A METHOD FOR CALCULATING CROSSFLOW SEPARATION PATTERNS ON SUBMARINE HULL/SAIL CONFIGURATIONS

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PREFACE

This report describes a method and a computer program for calculating the crossflow separation patterns on submarine hull/sail configurations. The method is based on inviscid flow solutions provided by a panel method and on solutions of the three-dimensional boundary-layer equations which incorporate the Cebeci-Smith eddy-viscosity formulation. The computer program embodies these two methods and an interface method with user friendly input and output subroutines. Calculated results are reported for submarine hull and submarine hull/sail configurations at incidence angles of 10 and 15 degrees and show that this numerical scheme, with its stability requirements, provides an efficient and accurate means of predicting crossflow separation patterns. A typical calculation time is around 30 seconds on a CRAY-2 computer for a submarine hull/sail configuration.

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1.0 INTRODUCTION

It is well known that flows around submarines are complex, involving unsteady vortices, local regions of flow separation and interaction between multiple shear layers. These phenomena occur even in the absence of sail, sonar equipment and control surfaces which each give rise to unsteady three-dimensional flows. The problem can be further complicated by the maneuvers through which the submarines are obliged to pass and by the interaction of the many shear layers with power producing propellers. Figure 1 shows a simplified hull with a sail and that, even at very small angles of attack, unsteady separated flows occur. It can be readily appreciated that the above features can lead to more complicated flow characteristics.

The performance of a submarine is affected by external flow characteristics in many ways. For example, the overall drag varies with the extent of flow separation and the performance of the propeller may be considerably impaired by asymmetric separated flow on the upstream plane. Even more important in some cases is the ability to maneuver with a predictable relationship between changes in yaw or angle of attack as caused by the control surfaces. As a further example, the separated flow patterns and their interaction with the propeller may give rise to pressure-fluctuation signals which can be detected

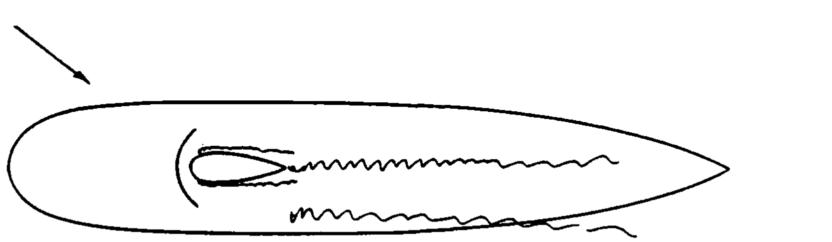


Fig. 1. (a) Side and (b) top views of vortices generated by flow separation.

remotely. Thus it is important that the consequences of a hull shape are known as a function of onset velocity and its variation with time. This report is concerned with the genesis of a method for providing this capability.

The flow patterns around a submarine, like those around any body, are represented by the time-dependent Navier-Stokes equations and solution of these would provide the necessary information. The excellent efforts of the Turbulence Center at Stanford University and at the NASA Ames Research Center have shown that these equations can be solved accurately for simple boundary conditions and for moderate Reynolds numbers. Equally, it is evident that flows around submarines do not conform to these simplifications so that the necessary solutions cannot be obtained and simplified forms of the Navier-Stokes equations must be solved with physical and numerical assumptions whose accuracy must be ascertained. Here we consider submarine hulls without and with sail and without control surfaces and propeller. We consider steady flow equations which are known to have limitations and address the problem of calculating the steady flow properties as a precursor to tackling the unsteady flow problem. In broad terms, there are two possible approaches to the solution of the steady flow problem and these are considered in the following paragraphs.

The steady form of the Navier-Stokes equations is able to represent the turbulent flows around the hull by the incorporation of assumptions for the Reynolds stresses which stem from the averaging procedure. These equations are elliptic with convection, pressure gradients and diffusion acting in three directions. Their solution involves interactive procedures, and computer resources imply that the numerical assumptions will give rise to uncertainties which can readily be as large as those due to the physical assumptions of the previous paragraph. Since the physical processes are most important within shear layers, an alternative approach is to solve reduced forms of the Navier-Stokes equations in which the diffusion in the longitudinal direction is neglected. This approach offers the considerable advantage that numerical uncertainties can be reduced virtually to zero with modest computing requirements. Of course, the neglect of longitudinal diffusion may prove to be important in some regions of local flow but it is expected that, in many cases, this will not matter to the overall flowfield. Even where this assumption is inappropriate, the results of solving the reduced equations can be used as starting conditions for the

full Navier-Stokes equations with consequent savings of computer resources and potential for improvement in numerical accuracy.

The calculations in this report were obtained by solving the inviscid flow equations to represent the outer flowfield and boundary-layer equations to represent the flow close to the surface. This approach can be improved in many ways but provides a first step towards a calculation tool which may be practically implementable. The second step is to permit interaction between the inner and outer flows, as indicated in Fig. 2, and this will be achieved by solving the boundary-layer equations in inverse form with interaction to ensure that the common boundary condition is satisfied. The interface program of Fig. 2 will be discussed as part of the calculation method described in Section 2.

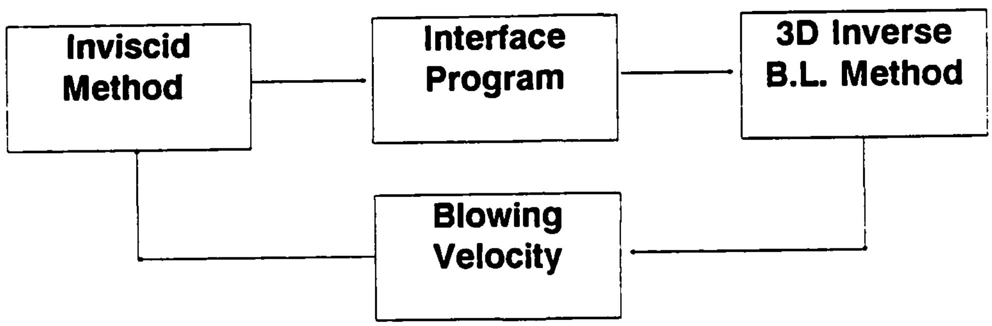


Fig. 2. The interactive boundary-layer method.

The description of the calculation method also includes a simple model to represent the Reynolds stress terms and leaves room for improvement if it proves to be necessary. Thus, the method provides a foundation upon which the added complications of interaction, unsteadiness, and more complicated closure assumptions can be built. The results are presented in Section 3 and correspond to a single-hull geometry whose shape is described in terms of discrete coordinates. The influence of angle of attack on the crossflow separation patterns is shown and subsequently the sail is incorporated and the calculations repeated for the same angles of attack. In all cases, the boundary-layer equations are solved in their standard form with the external pressure distribution obtained from the solution of the inviscid flow equations. Section 4 describes the input and output of the computer program and Section 5 presents two sample calculations.

2.0 DESCRIPTION OF THE CALCULATION METHOD

The calculation method of Fig. 2 is designed so that it can be used to perform inviscid and viscous flow calculations interactively. Again, as in two-dimensional flows, a panel method is used to calculate the three-dimensional external velocity distribution needed in the boundary-layer calculations. An interface program is placed between the inviscid and three-dimensional inverse boundary-layer methods to process the geometry and inviscid velocity data for input into the boundary-layer program. The basic input for the overall calculation is the definition of the submarine hull and sail configuration. This information is used by a geometry subroutine to construct an orthogonal coordinate system for inviscid flow calculaions. The inviscid velocity components on the surface calculated in a Cartesian coordinate system are then transformed into components in the boundary-layer coordinate system. This operation consists of dot products of velocity vectors as well as axial and circumferential interpolation. Since the flow has a plane of symmetry, the input data is arranged only for the half of the body with boundary-layer calculations starting on the bottom line of symmetry and marching towards the upper line of symmetry.

The heart of the interactive scheme is the three-dimensional boundary-layer method which will later be formulated in inverse mode. The governing equations correspond to the continuity and momentum equations, for an orthogonal system with Reynolds stresses modeled by an eddy-viscosity concept, can be written [1] as

Continuity:

$$\frac{\partial}{\partial x}(uh_2) + \frac{\partial}{\partial z}(wh_1) + \frac{\partial}{\partial y}(vh_1h_2) = 0 \tag{1}$$

x-Momentum:

$$\frac{u}{h_1}\frac{\partial u}{\partial x} + \frac{w}{h_2}\frac{\partial u}{\partial z} + v\frac{\partial u}{\partial y} + K_2w^2 - K_1uw = -\frac{1}{h_1\rho}\frac{\partial p}{\partial x} + \nu\frac{\partial}{\partial y}\left(b\frac{\partial u}{\partial y}\right) \tag{2}$$

z-Momentum:

$$\frac{u}{h_1}\frac{\partial w}{\partial x} + \frac{w}{h_2}\frac{\partial w}{\partial z} + v\frac{\partial w}{\partial y} + K_1u^2 - K_2uw = -\frac{1}{h_2\rho}\frac{\partial p}{\partial z} + \nu\frac{\partial}{\partial y}\left(b\frac{\partial w}{\partial y}\right) \tag{3}$$

Here $b = 1 + \varepsilon_m/\nu$, x denotes the axial direction, z the circumferential direction, and y is normal to the surface. The parameters $h_1(x,z)$ and $h_2(x,z)$ denote

surface metric coefficients. The parameters K_1 and K_2 are the geodesic curvatures of the curves z = const and x = const, respectively, and are given by

$$K_1 = -\frac{1}{h_1 h_2}\frac{\partial h_1}{\partial z}, \quad K_2 = -\frac{1}{h_1 h_2}\frac{\partial h_2}{\partial x} \tag{4}$$

In the absence of mass transfer, the above equations are subject to the following boundary conditions

$$\begin{aligned} y &= 0, \quad u = v = w = 0; \\ y &= \delta, \quad u = u_e(x,z), \quad w = w_e(x,z) \end{aligned} \tag{5}$$

The solution of Eqs. (1) to (3), subject to the boundary conditions given by Eq. (5), requires initial conditions in the (x,y)-plane at some $z = z_0$ and initial conditions in the (y,z)-plane at $x = x_0$. In the former case, we make use of the line of symmetry conditions; we take w and $\partial p/\partial z$ to be zero along this line and differentiate Eq. (3) with respect to z. The appropriate equations then, with $w_z = \partial w/\partial z$, can be written as

$$\frac{\partial}{\partial x} uh_2 + h_1 w_z + \frac{\partial}{\partial y} vh_1h_2 = 0 \tag{6}$$

$$\frac{u}{h_1}\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = -\frac{1}{h_1\rho}\frac{\partial p}{\partial x} + \nu\frac{\partial}{\partial y}\left(b\frac{\partial u}{\partial y}\right) \tag{7}$$

$$\frac{u}{h_1}\frac{\partial w_z}{\partial x} + \frac{1}{h_2}w_z^2 + v\frac{\partial w_z}{\partial y} - K_2uw_z + \frac{\partial K_1}{\partial z}u^2 = -\frac{1}{h_2\rho}\frac{\partial^2 p}{\partial z^2} + \nu\frac{\partial}{\partial y}\left(b\frac{\partial w_z}{\partial y}\right) \tag{8}$$

$$\begin{aligned} y &= 0, \quad u = v = w_z = 0; \\ y &= \delta, \quad u = u_e(x,z), \quad w_z = w_{ze}(x,z) \end{aligned} \tag{9}$$

The above equations can be solved when they are expressed either in physical or transformed coordinates - each of which has its own advantages. In three-dimensional flows where the computer storage and time are particularly important, transformed coordinates become a must as well as convenient because they allow large steps to be taken in the streamwise and circumferential directions. In addition, they generate the initial conditions with ease and reduce the growth in boundary-layer thickness with increasing x.

In our method we use a form of the Falkner-Skan transformation defined by

$$\frac{ds_1}{dx} = h_1, \qquad \eta = \left(\frac{u_0}{\nu s_1}\right)^{1/2} dy \tag{10}$$

A two-component vector potential is introduced such that

$$uh_2 = \frac{\partial\psi}{\partial y}, \quad wh_1 = \frac{\partial\Phi}{\partial y}, \quad vh_1h_2 = -\left(\frac{\partial\psi}{\partial x} + \frac{\partial\Phi}{\partial z}\right) \tag{11}$$

where ψ and Φ, with u_0 denoting a reference velocity, are defined by

$$\begin{aligned} \psi &= (\nu u_0 s_1)^{1/2} h_2 f(x,z,\eta), \\ \Phi &= (\nu u_0 s_1)^{1/2} h_1 g(x,z,\eta), \end{aligned} \tag{12}$$

With this transformation, it can be shown that the three-dimensional boundary-layer equations, Eqs. (1) to (3), and their boundary conditions, Eq. (5), can be written in the following general form

$$\begin{aligned} (bf'')' + m_1 ff'' + m_3 f'g' + m_4 gf'' + m_5 (g')^2 + m_6 &= m_7\left(f' \frac{\partial f'}{\partial x} - f'' \frac{\partial f}{\partial x}\right) \\ &+ m_8\left(g' \frac{\partial f'}{\partial z} - f'' \frac{\partial g}{\partial z}\right) \end{aligned} \tag{13}$$

$$\begin{aligned} (bg'')' + m_9 fg'' + m_{11} f'g' + m_{12} gg'' + m_{13}(f')^2 + m_{14} \\ = m_7\left(f' \frac{\partial g'}{\partial x} - g'' \frac{\partial f}{\partial x}\right) + m_8\left(g' \frac{\partial g'}{\partial z} - g'' \frac{\partial g}{\partial z}\right) \end{aligned} \tag{14}$$

$$\begin{aligned} &\eta = 0, \quad f = g = f' = g' = 0; \\ &\eta = \eta_e, \quad f' = u_e/u_0 \equiv \bar{u}_e, \quad g' = w_e/u_0 \equiv \bar{w}_e \end{aligned} \tag{15}$$

Here primes denote differentiation with respect to η and $f' = u/u_0$, $g' = w/u_0$. The coefficients m_1 to m_{14} are given by

$$\begin{aligned} &m_1 = \frac{1}{2} - K_2 s_1, \quad m_3 = -K_1 s_1, \quad m_4 = \frac{\sqrt{s_1}}{h_1 h_2} \frac{\partial}{\partial z} (\sqrt{s_1} h_1), \quad m_5 = -K_2 s_1 \\ &m_6 = \frac{s_1}{u_0^2} \left[\frac{u_e}{h_1} \frac{\partial u_e}{\partial x} + \frac{w_e}{h_2} \frac{\partial u_e}{\partial z} + K_2 w_e^2 + K_1 u_e w_e\right] \end{aligned} \tag{16}$$

$$m_7 = \frac{s_1}{h_1}, \quad m_8 = \frac{s_1}{h_2}, \quad m_9 = m_1,$$

$$m_{11} = K_2 s_1, \quad m_{12} = m_4, \quad m_{13} = - K_1 s_1$$

$$m_{14} = \frac{s_1}{u_o^2} [\frac{u_e}{h_1} \frac{\partial w_e}{\partial x} + \frac{w_e}{h_2} \frac{\partial w_e}{\partial z} + K_1 u_e^2 - K_2 u_e w_e]$$

Similarly, with the transformation given by Eqs. (10) and (12), and with

$$uh_2 = \frac{\partial \psi}{\partial y}, \quad w_z h_1 = \frac{\partial \Phi}{\partial y}, \quad vh_1 h_2 = -(\frac{\partial \psi}{\partial x} + \Phi) \tag{17}$$

the line of symmetry equations and their boundary conditions, Eqs. (6) to (9) can be expressed in forms similar to those of Eqs. (13) to (16),

$$(bf")' + m_1 ff" + m_8 gf" + m_{15} = m_7 (f' \frac{\partial f'}{\partial x} - f" \frac{\partial f}{\partial x}) \tag{18}$$

$$(bg")' + m_9 fg" + m_{11} f'g' + m_8 gg" - m_8 (g')^2 + m_{16} (f')^2 + m_{17}$$
$$= m_7 (f' \frac{\partial g'}{\partial x} - g" \frac{\partial f}{\partial x}) \tag{19}$$

$$\eta = 0, \quad f = g = f' = g' = 0;$$
$$\eta = \eta_e, \quad f' = \bar{u}_e, \quad g' = \frac{w_{ze}}{u_o} \equiv \bar{w}_{ze} \tag{20}$$

where the m coefficients are given by Eq. (16) except that

$$m_{15} = \frac{s_1}{u_o^2} \frac{u_e}{h_1} \frac{\partial u_e}{\partial x}, \quad m_{16} = - s_1 \frac{\partial K_1}{\partial z}$$

$$m_{17} = \frac{s_1}{u_o^2} [\frac{u_e}{h_1} \frac{Mw_{ze}}{Mx} + \frac{1}{h_2} (w_{ze})^2 - K_2 u_e w_{ze} + \frac{\partial K_1}{\partial z} u_e^2]$$

Equations (18) and (19) can be solved first at the stagnation point on the bottom line of symmetry. There is no problem in generating the solutions downstream of this point in contrast to those upstream of the stagnation point. Since a body-oriented coordinate system is used in our method, the metric coefficients and the geodesic curvatures are singular at the nose of the body. A common procedure to circumvent this unpleasant singularity is to

revert to an approximate procedure by performing the integration along a coordinate line from the stagnation point to the upper line of symmetry. Accurate procedures, however, are available and discussed in Ref. 2.

In the present method, the initial conditions in the (η,z)-plane are obtained by an approximate procedure in which the x-derivatives in Eqs. (13) and (14), such as $\partial f'/\partial x$, $\partial f/\partial x$ and $\partial g'/\partial x$ are neglected and those on the (x,η)-plane by the solutions of the line-of-symmetry equations, (18) to (20).

Keller's two-point finite-difference method is used to solve the equations with the boundary-layer equations first written as a first-order system. Then, for a net cube in which the net points are defined by

$$\begin{aligned} x_o &= 0, \quad x_i = x_{i-1} + r_i, \quad i = 1, 2, \ldots, I \\ z_o &= 0, \quad z_n = z_{n-1} + k_n, \quad n = 1, 2, \ldots, N \\ \eta_o &= 0, \quad \eta_j = \eta_{j-1} + h_j, \quad j = 1, 2, \ldots, J \end{aligned} \tag{21}$$

where $r_i = \Delta x_i$, $k_n = \Delta z_n$ and $h_j = \Delta \eta_j$, difference approximations are written about the midpoint of $(x_i, z_n, \eta_{j-1/2})$ and $(x_{i-1/2}, z_{n-1/2}, \eta_{j-1/2})$ as described in Ref. 1. The resulting nonlinear system is then linearized by Newton's method before it is solved with the block-elimination algorithm, also discussed in Ref. 1.

As long as both u and w are positive across the boundary layer, this scheme is efficient and accurate. When the circumferential velocity w becomes negative, however, it requires modification by the characteristic method developed by Cebeci and Stewartson [1]. Equations (13) and (14) are expressed along the local streamlines, by first defining θ by

$$\theta = m_1 f + m_4 g + m_7 \frac{\partial f}{\partial x} + m_8 \frac{\partial g}{\partial z} \tag{22}$$

and writing Eqs. (13) and (14) as

$$(bf'')' + f''\theta + m_3 f'g' + m_5 (g')^2 + m_6 = \lambda \frac{\partial f'}{\partial \psi} \tag{23}$$

$$(bg'')' + g''\theta + m_{11} f'g' + m_{13} (f')^2 + m_{14} = \lambda \frac{\partial g'}{\partial \psi} \tag{24}$$

where

$$\lambda = \sqrt{(m_7 f')^2 + (m_8 g')^2} \tag{25a}$$

$$\Delta\psi = \frac{r_i}{\cos\gamma}, \quad \gamma = \tan^{-1}\left(\frac{m_8 g'}{m_7 f'}\right) \tag{25b}$$

In this method, again the equations are expressed as a first-order system; for example, with $f' = u$, $g' = w$, new variables v and t are defined by

$$u' = v \tag{26a}$$

$$w' = t \tag{26b}$$

and Eqs. (22) to (24) are written as

$$\theta' = m_1 u + m_4 w + m_7 \frac{\partial u}{\partial x} + m_8 \frac{\partial w}{\partial z} \tag{26c}$$

$$(bv)' + v\theta + m_3 uw + m_5 w^2 + m_6 = \lambda \frac{\partial u}{\partial \psi} \tag{26d}$$

$$(bt)' + t\theta + m_{11} uw + m_{13} u^2 + m_{14} = \lambda \frac{\partial w}{\partial \psi} \tag{26e}$$

The difference approximations to Eqs. (26a) and (26b) are obtained by averaging about the midpoint $(x_i, z_n, \eta_{j-1/2})$,

$$h_j^{-1}(u_j^{i,n} - u_{j-1}^{i,n}) = v_{j-1/2}^{i,n} \tag{27a}$$

$$h_j^{-1}(w_j^{i,n} - w_{j-1}^{i,n}) = t_{j-1/2}^{i,n} \tag{27b}$$

where, for example,

$$v_{j-1/2}^{i,n} = \frac{1}{2}(v_j^{i,n} + v_{j-1}^{i,n})$$

The difference equations to Eqs. (26d) and (26e) are written along the streamline direction (see Fig. 3) at point P; for example, for Eq. (26d), they are:

$$\begin{aligned} h_j^{-1}[(bv)_j^{i,n} - (bv)_{j-1}^{i,n}] + A\theta_{j-1/2}^{i-1/2,n-1/2}(v_{j-1/2}^{i,n} + v_{j-1/2}^{s}) + B\theta_{j-1/2}^{i-1/2,n-3/2} v_{j-1/2}^{i,n} \\ + (m_3)^{i,n}(uw)_{j-1/2}^{i,n} + (m_5)^{i,n}(w^2)_{j-1/2}^{i,n} \\ - 2\lambda_{j-1/2}^{p}(u_{j-1/2}^{i,n} - u_{j-1/2}^{s})/\Delta\psi = R_{j-1/2}^{I} \end{aligned} \tag{28}$$

where

$$R^{I}_{j-1/2} = -(L_I)^s_{j-1/2} - B\theta^{i-1/2,n-3/2}_{j-1/2} v^s_{j-1/2} - 2(m_6)^p$$

$$L_I = (bv)' + m_3 uw + m_5 w^2 \tag{29}$$

$$A = 1 + \frac{k_n - r_i \tan\gamma}{k_n + k_{n-1}}, \qquad B = \frac{r_i \tan\gamma - k_n}{k_n + k_{n-1}}$$

The nonlinear difference equations are then linearized again by Newton's method and the resulting system solved with the algorithm based on the block-elimination method.

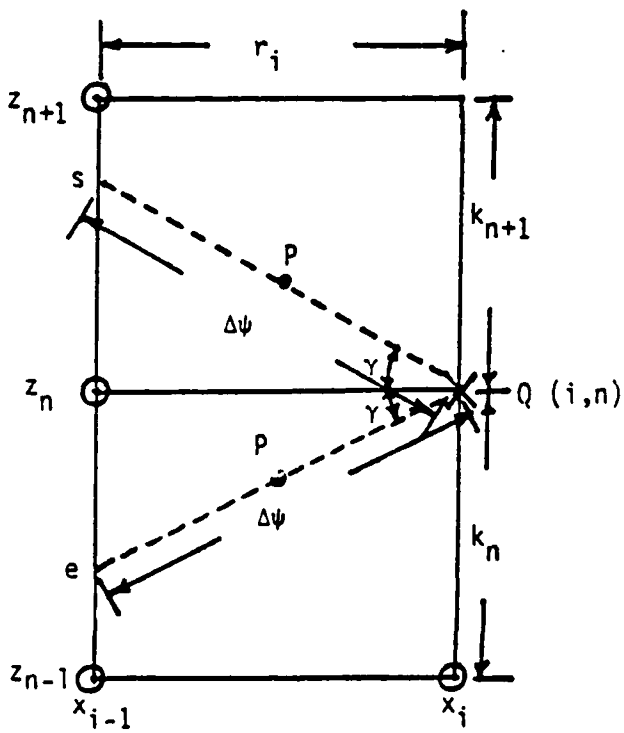


Fig. 3. Finite-difference notation for the characteristic box scheme. Dashed lines denote the local streamlines at a given j-point: 0, known; x, unknown.

It is useful to note that the characteristic method described above is an "intelligent" scheme which examines the finite-difference grid in relation to the magnitude and direction of local velocities and reaches and implements a decision to ensure that a stability criterion similar to the the Courant, Friedrichs and Lewy stability criterion[3] is not violated. To discuss this stability requirement further, let us consider the net of Fig. 3 at a given distance, y, from the surface. The backward characteristic from point Q is in the local streamline direction and intersects the x_{i-1} line at e when there is a positive crossflow velocity and at s when the crossflow velocity is negative. Since the characteristic box covers the region esQ, which is known as the domain of dependence of point Q, it ensures that necessary information reaches point Q from the x_{i-1} line. It is important that the domain of stable computations can be determined a priori and this is achieved by determining the ratio $[(s - z_n)/(z_{n+1} - z_n)]$ or $[(z_n - e)/(z_{n+1} - z_n)]$, which is also equal to $(w/u)(h_1/h_2)(r_i/k_n)$ and requiring that it remains small during the calculations.

3.0 RESULTS AND DISCUSSION

Calculations using the method of the previous section were performed for a submarine hull and submarine hull/sail combination. The model configurations chosen for this investigation were designed for the Defense Advanced Research Projects Agency (DARPA) SUBOFF project at David Taylor Research Center (DTRC). The equations and model details that define the axisymmetric body and sail are given in Ref. 4. The body has an overall length of 14.29 ft and a maximum diameter of 1.67 ft. The hull (see Fig. 4) comprised a forebody of length 3.33 ft, a parallel middle body section of length 7.31 ft, an afterbody of length 3.65 ft and an afterbody cap of length 0.3125 ft. The equation for each hull component is given in terms of axial, X, and radial distance, R = R(X). The sail is located on the hull at top dead center with its leading edge positioned at X = 3.03 ft and trailing edge at X = 4.24 ft for a total length of 1.21 ft. A sail cap attaches to the top of the sail at a height, Z = 1.51 ft. In addition to the sail cap, the sail is defined in terms of a forebody, a parallel middle body and an afterbody region, see Fig. 5. Note that X, Y, Z denote the Cartesian coordinates used to define the geometry.

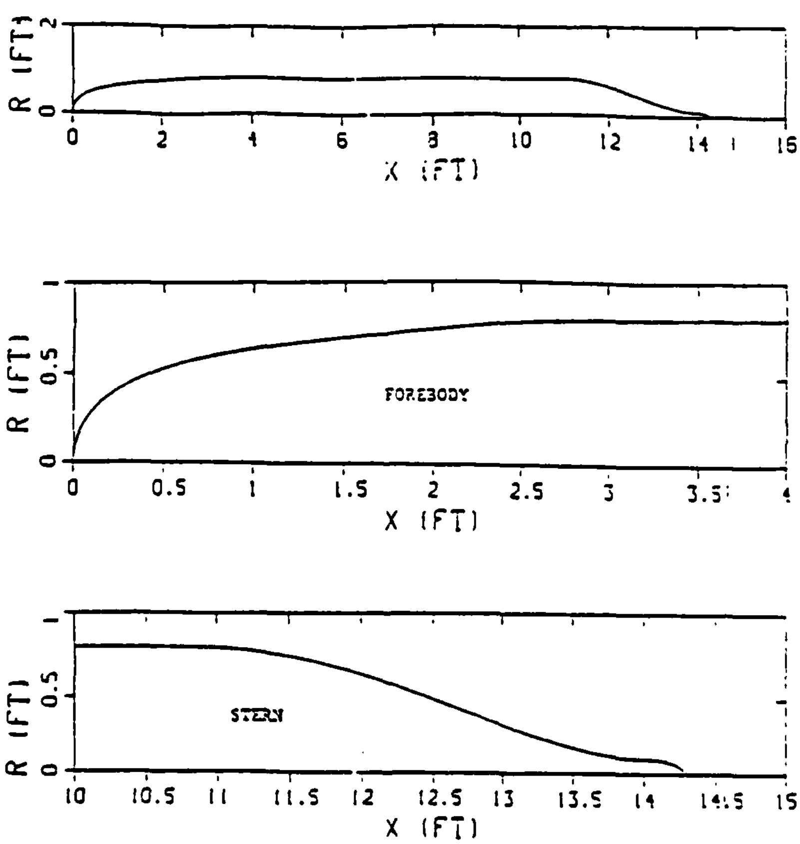


Fig. 4. Hull profile.

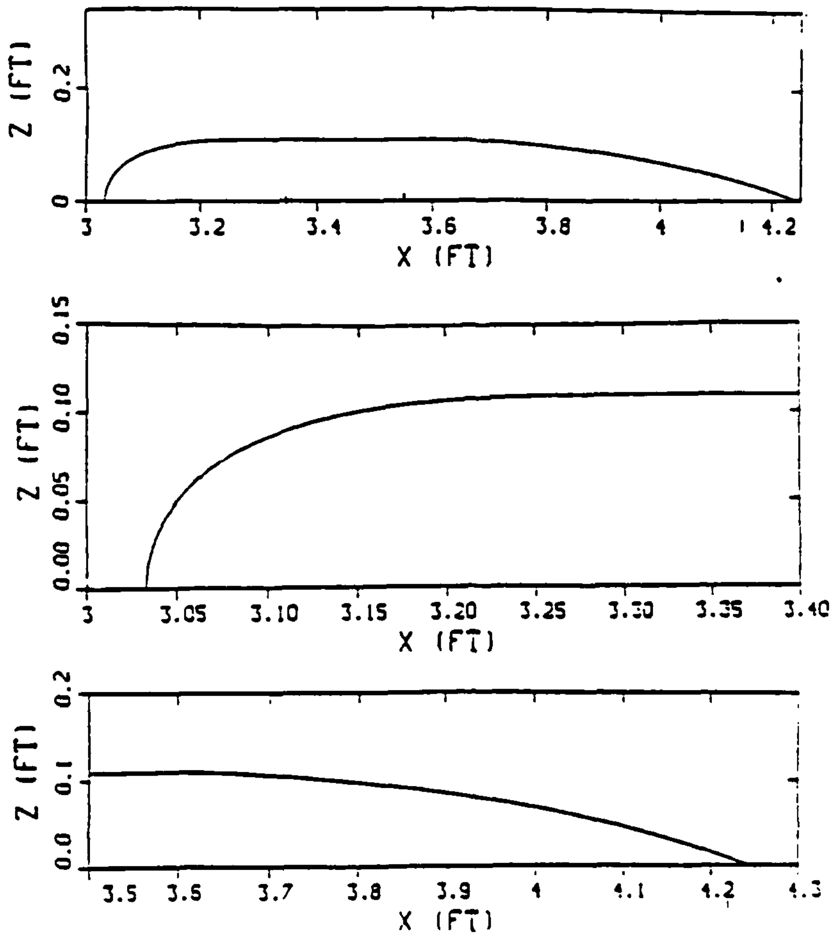


Fig. 5. Sail section profile.

The inviscid pressure distribution was obtained from a three-dimensional panel method identical to that of Hess[5] and coded by Egan[6]. Since boundary-layer calculations require a much finer grid than that used in the panel code, the velocity components, v_X, v_Y, v_Z, obtained from the panel code were interpolated for a specified boundary-layer grid and the edge velocities u_e and w_e needed in boundary-layer calculations were calculated from

$$\begin{aligned} u_e &= v_X \cos\beta + \sin\beta \, (v_Y \sin\phi - v_Z \cos\phi) \\ w_e &= v_Y \cos\phi + v_Z \sin\phi \end{aligned} \tag{30}$$

in the interface program. Here β is calculated from

$$\beta = \tan^{-1} \frac{dR}{dX}$$

and ϕ, which denotes the polar angle, is calculated from the panel centroid locations, that is,

$$\phi = \tan^{-1}(-\frac{Y}{Z})$$

Due to the storage limitations, the inviscid code had a capability of 2000 panels which was sufficient except in some regions of the afterbody cap.

The metric coefficients and geodesic curvatures appearing in the boundary-layer equations were calculated in the interface program by the following expressions

$$h_1 = \frac{1}{\cos\beta}, \qquad h_2 = R(X)$$
$$K_1 = 0, \qquad K_2 = -\frac{\sin\beta}{R(X)}, \tag{31}$$

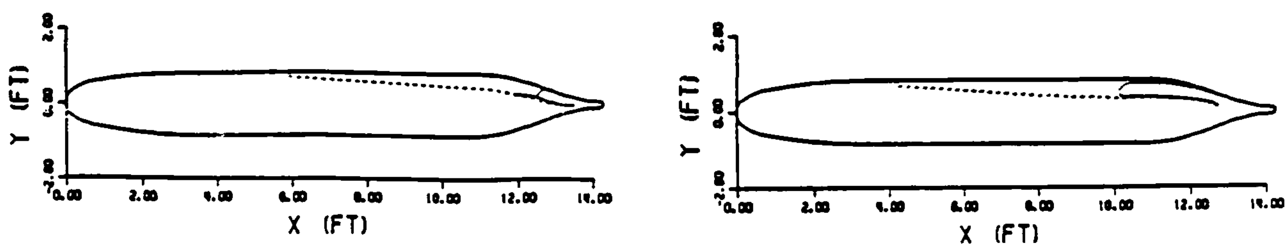
for each configuration.

In the following two subsections, we present the calculated results first for the submarine hull configuration (Section 3.1) and then for the submarine hull/sail configuration (Section 3.2).

3.1 Results for Submarine Hull Configuration

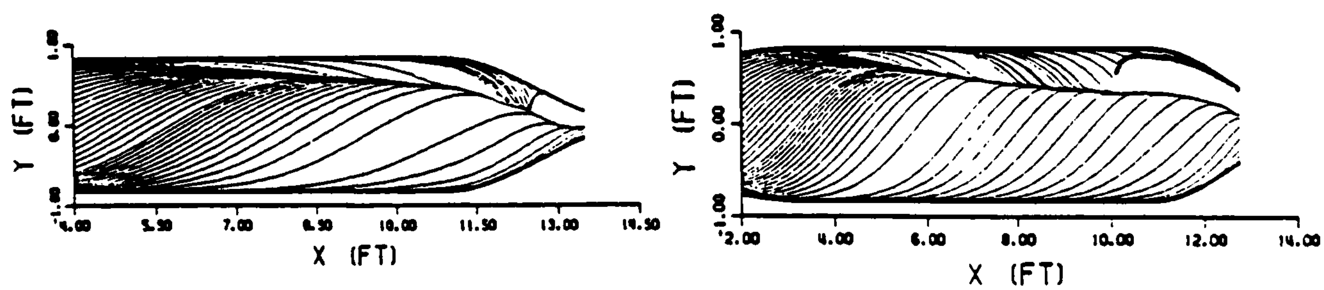
Calculations for this configuration were performed at a Reynolds number of 1.4 x 10^6/ft and for angles of attack corresponding to $\alpha = 10°$ and 15°. In regions of no reverse crossflow, relatively large steps in the streamwise direction were taken. In regions of negative crossflow, however, the step sizes were smaller and were chosen to satisfy the stability criterion required by the characteristic box scheme. For example, for $\alpha = 10°$ and 15°, around 15 x-stations were taken in the range $0.001 \leq x \leq 0.5$. For $\alpha = 10°$, cross-flow separation began around $x = 5.8$; the r_1-step spacing for this angle of attack was uniform with $r_1 = 0.1$ in the range $0.5 \leq x \leq 6.5$. For $\alpha = 15°$, crossflow separation occurred earlier at $x = 4$ and we used the same Δx-spacing but changed the range to $0.5 \leq x \leq 5.0$. In the region of cross-flow separation, the step length r_1 was reduced to 0.05 for two angles of attack, for the range of x confined to $6.5 \leq x \leq 13.5$ for $\alpha = 10°$ and $5.0 \leq x \leq 12.75$ for $\alpha = 15°$.

Figures 6 and 7 show a sample of the calculated results for two incidence angles. Figures 6a and 6b show the crossflow separation patterns (dashed line) together with a line called "terminal line" (solid line) which corresponds to the limit of the calculations for specified pressure distributions t $\alpha = 10°$ and 15°, respectively. Figures 7a and 7b show the behavior of the limiting streamlines obtained by integrating the direction field of the wall shear $h_1 g_w''/h_2 f_w''$ as a function of x at specified initial values of ϕ. It is interesting to note that, prior to the terminal line, even though the behavior of the streamlines is such that they seem to form an envelope, which does not correspond to flow separation since the solutions are regular. The beginning of the terminal line occurs at $x = 12.5$ ft for $\alpha = 10°$ and $x = 10$ ft for $\alpha = 15°$ and corresponds to the breakdown of the calculations. To calculate the region between the two terminal lines, it is necessary to use the inverse boundary-layer procedure currently under development.



(a) (b)

Fig. 6. Crossflow separation pattern on a submarine hull at incidences of (a) 10°, and (b) 15°. Solid line denotes the terminal line.



(a) (b)

Fig. 7. Limiting streamlines on submarine hull at incidences of (a) 10°, and (b) 15°.

Figures 8 and 9 show the variation of the wall shear parameters f''_w and g''_w in the circumferential direction at several values of x for $\alpha = 15°$. As can be seen, the computed wall shear parameters, which are the most sensitive parameters of all the boundary-layer quantities, are smooth and free of oscillations. The breakdown of the calculations occurs at a location where the dip in negative g''_w is maximum for a value of x slightly greater than 10 ft at a circumferential location of around 120°. It is possible that the beginning of the terminal line may also signal the start of the streamwise flow separation line. Its pattern and nature, and whether or not it differs from the separation patterns identified on a prolate spheroid discussed in Ref. 7, however, require and deserve separate studies.

The calculations up to the terminal line took less than one minute of CRAY-2 computer time for each angle of attack. If the calculations are restricted only to the prediction of the crossflow separation pattern, however, a typical computer time is around 30 seconds.

3.2 Results for Submarine Hull/Sail Configuration

Calculations for this configuration were made essentially in the same way as those for the submarine hull with the same x-grid distribution used for x ≤

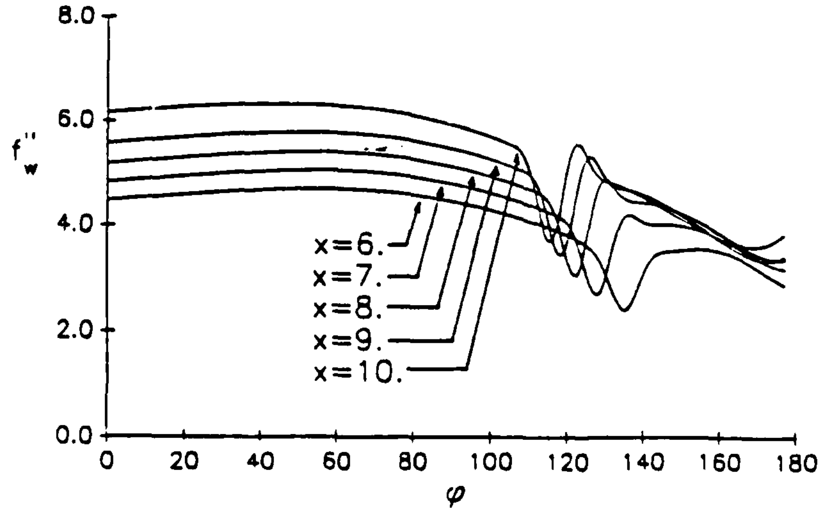


Fig. 8. Variation of the streamwise wall shear parameter f''_w with ϕ at several values of x for the submarine hull configuration, $\alpha = 15°$.

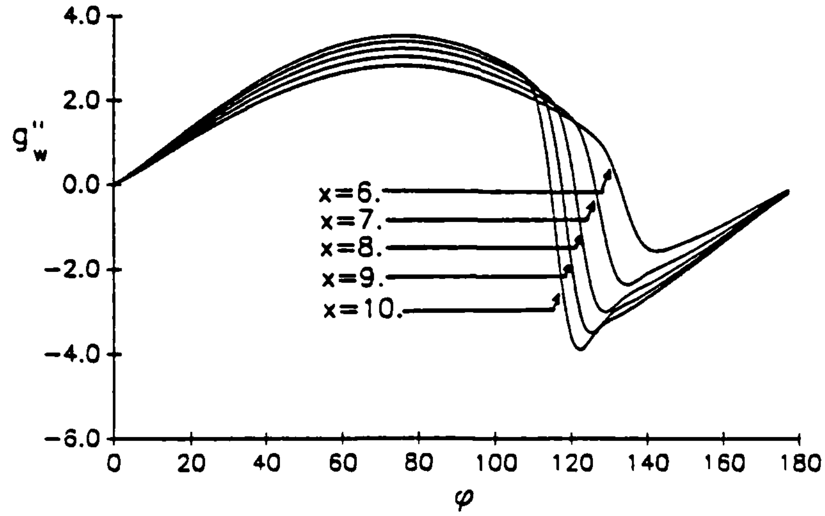


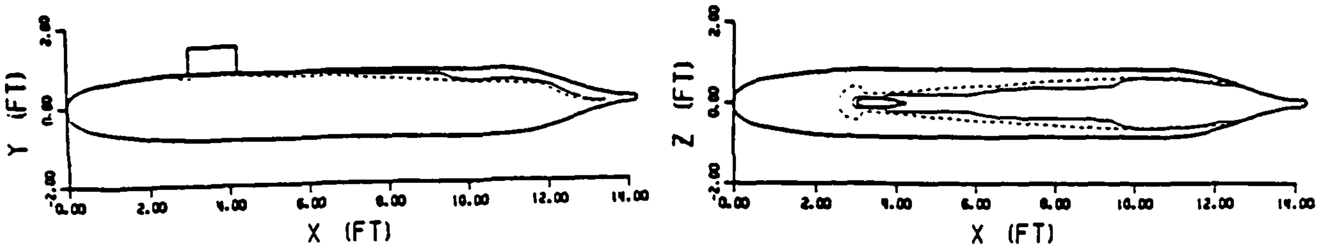
Fig. 9. Variation of the circumferential wall shear parameter g''_w with ϕ at several values of x for the submarine hull configuration, $\alpha = 15°$.

0.5. In the region $0.5 \leq x \leq 2.5$, r_1 was 0.1 for both angles of attack and was reduced to 0.05 for $2.5 \leq x \leq 2.8$ and to 0.025 for $x < 3.20$. For $3.2 \leq x \leq 4.5$, r_1 was taken as 0.05 and was increased to 0.1 for $4.5 \leq x \leq 10.5$. After this, r_1 was reduced to 0.05 for $10.5 \leq x \leq 13.5$.

Figures 10 and 11 show the calculated crossflow separation patterns for two angles of attack. Figure 10 shows the side and top views at $\alpha = 10°$. The dashed lines denote cross-flow separation and solid lines those corresponding to the terminal lines which represent the breakdown of the solutions. In order to extend the calculations beyond the solid line, it is again necessary to use the inverse boundary-layer method presently under development.

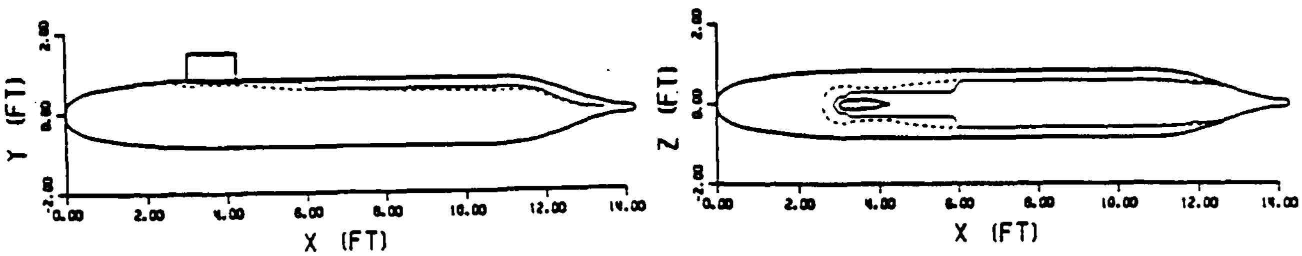
Figure 11 shows results similar to those in Fig. 10 for $\alpha = 15°$ and the extent of crossflow separation becomes more significant, with increased incidence angle. As at other angles of attack, the solutions do not indicate oscillations provided that the grid is properly chosen.

Figures 12 and 13 show the variation of the wall shear parameters f''_w and g''_w, in the circumferential direction, at several values of x for $\alpha = 15°$. Comparison of these results with those given in Figs. 8 and 9 obtained for a submarine hull shows that the crossflow separation line and negative crossflow



(a) (b)

Fig. 10. Crossflow separation patterns on a submarine hull/sail configuration at $\alpha = 10°$: (a) side view, (b) top view. Solid line denotes the terminal line.



(a) (b)

Fig. 11. Crossflow separation patterns on a submarine hull/sail configuration at $\alpha = 15°$: (a) side view, (b) top view. Solid line denotes the terminal line.

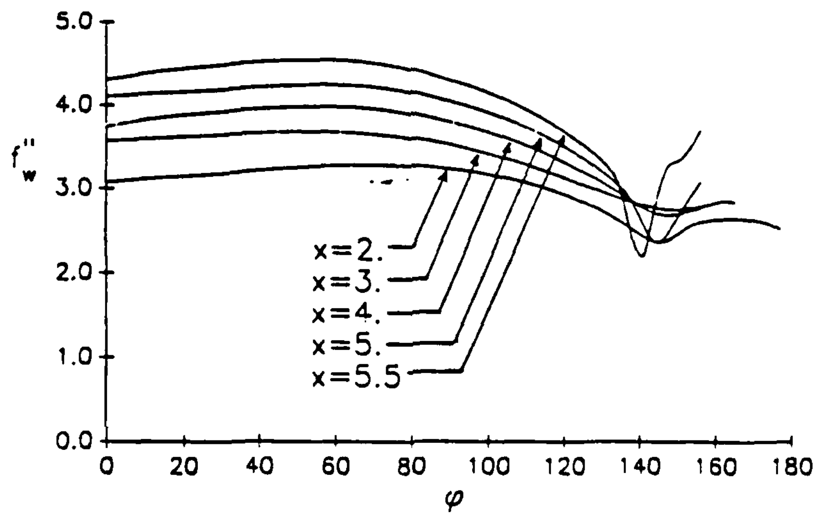


Fig. 12. Variation of the streamwise wall shear parameter f''_w with ϕ at several values of x for the submarine hull/sail configuration, $\alpha = 15°$.

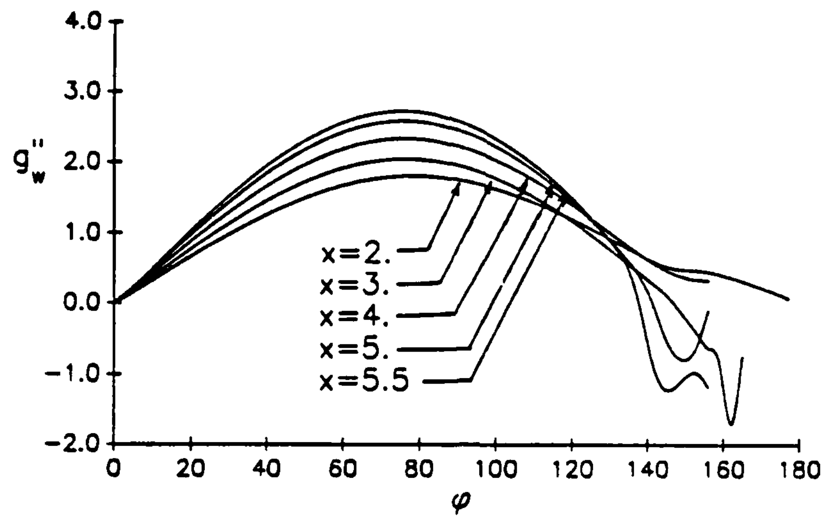


Fig. 13. Variation of the circumferential wall shear parameter g_w'' with ϕ at several values of x for the submarine hull/sail configuration, α = 15°.

region move upstream in the presence of the sail and for both angles of attack the separation is located ahead of the sail where, except very close to the sail, the calculations in the circumferential direction at specified values of x, proceeded all the way to the upper line of symmetry without any numerical problems. Very close to the sail, crossflow flow separation occurs but is restricted to a very small circumferential region. As we get closer to the sail/hull juncture, again the calculations broke down and led to a terminal line. When this situation occurred, we switched to the next streamwise x-location and continued the solution procedure in the circumferential direction. The results in Fig. 13 also indicate that in the region of sail, the magnitudes of the maximum negative crossflow wall shear, g_w'', are not as big as those on the submarine hull. This may be one of the main reasons why the solutions are not as sensitive to the boundary-layer net as those that led to the results in Fig. 9.

4.0 DESCRIPTION OF THE COMPUTER PROGRAM

The present computer program performs laminar and turbulent boundary-layer calculations for a submarine hull and submarine hull/sail combination at different angles of attack. The inviscid velocity distribution is determined from the three-dimensional panel method. A brief summary of the overall calculation procedure is given as follows:

1. A subroutine GEOMTRY is called to generate the coordinates of the grid points on submarine hull or submarine hull/sail as inputs to the three-dimensional panel method.

2. The inviscid pressure distribution is computed for a given geometry and angle of attack with a three-dimensional panel method described in Ref. 6.

3. The edge velocities u_e, w_e are then calculated and interpolated into a finer mesh for boundary-layer calculations. The metric coefficients h_1, h_2 and the geodesic curvature parameters K_1 and K_2 are determined and the m-coefficients given by Eq. (16) are calculated. These calculations are done in a subroutine INTRFCE.

4. Three-dimensional boundary-layer calculations are performed to compute the crossflow separation patterns.

There are 8 Fortran unit files in the code as described below:

Unit 11: Contains input grid points for both inviscid and boundary-layer calculations.

Unit 21: Contains coordinates of grid points generated by subroutine GEOMTRY and is used as input to the three-dimensional panel method.

Unit 31: Stores the A_{ij} matrix for the three-dimensional panel method.

Unit 32: Stores Kutta condition coefficients.

Unit 33: Stores the V_{ij} on-body velocity influence matrix for the three-dimensional panel method.

Unit 34: Stores the V_{ij} off-body velocity influence matrix for the three-dimensional panel method.

Unit 41: Contains results of the three-dimensional panel method that provides inviscid velocity distribution to subroutine INTRFCE.

Unit 51: Contains a summary of boundary-layer parameters calculated with this computer program.

4.1 Input

There are two input files for this computer program: unit 5 for control flags and unit 11 for grid points. A detailed description of each is given below;

4.1.1 Unit 5

Card 01 (I5, F10.5)

ISYMT	1 No symmetry 2 Positive symmetry in y
REFAREA	Reference area

Card 02 (F10.5)

ALP	Angle of attack (degrees)

Card 03 (19A4)

TITLE	Title for the next card

Card 04 (7F10.5)

ETAE	Transformed boundary-layer thickness, η_e
VGP	Variable grid parameter
DETA(1)	Length of first grid, $\Delta\eta_1$
RL	Reynolds number per unit length

Card 05 (15I5)

NXTR(I), I=1,NZT	Transition location of each circumferential section for boundary-layer calculations.

4.1.2 Unit 11

Card 01 (I5)

IFSAIL	0 Calculation is for submarine hull only 1 Calculation is for submarine hull/sail combination

Card 02 (2I5)

NX	Number of points on submarine hull along the X direction for inviscid flow calculations.
NPHI	Number of points on submarine hull along the circumferential direction for inviscid flow calculations.

Card 03 (7F10.5)

PHI(I), I=1,NPHI	The ϕ-coordinate of the submarine hull for inviscid flow calculations. $\phi = \tan^{-1}(-Y/Z)$ ϕ is given in degrees.

Card 04 (7F10.5)

X(I), I=1,NX	The X coordinate of the submarine hull for inviscid flow calculation.

Card 05 to Card 08 will only be read if IFSAIL=1

Card 05 (I5)

NSAIL	Number of points on sail along the X direction for inviscid flow calculations.

Card 06 (7F10.5)

X(I), I=1, NSAIL	The X coordinate of the sail for inviscid flow calculations. Note that the input points begin at the trailing edge and end at the leading edge according to the order of input points used in the three-dimensional panel method.

Card 07 (I5)

NCAP	Number of points of sail cap along the X direction for inviscid flow calculation.

Card 08 (7F10.5)

X(I), I=1, NCAP	The X coordinate of the sail cap for inviscid flow calculation. Note that the input points begin at the leading edge and end at the trailing edge.

Card 09 (2I5)

NXT	Number of points along the x-direction for boundary-layer calculations.
NZT	Number of points along the z- (circumferential) direction for boundary-layer calculations.

Card 10 (7F10.5)

X(I), I=1,NXT	The x-coordinate for boundary-layer calculations.

Card 11 (7F10.5)

Z(I), I=1,NZT	The z-coordinate for boundary-layer calculations. Note that z is in degrees.

4.2 Output

The output from the inviscid flow calculations contains the following information:

IL	Index of the strip number of the section.
IC	Index of the element number of the strip.
X	X-coordinate of the centroid of each element.
Y	Y-coordinate of the centroid of each element.
Z	Z-coordinate of the centroid of each element.
SIGMA	Surface source density
VN	Normal velocity at the centroid of each element
VX	X-component of the velocity
VY	Y-component of the velocity
VZ	Z-component of the velocity
VT	Magnitude of the total velocity
CP	Pressure coefficient

The output from the boundary-layer calculations contains the following information:

NX	Index of the station number along x-direction
NZ	Index of the station number along z-direction
X(NX)	x-coordinate of the station NX
Z(NZ)	z-coordinate of the station NZ
V(WALL)	Streamwise wall shear parameter f''_w
T(WALL)	Circumferential wall shear parameter g''_w
UE	x-component of the external velocity
WE	z-component of the external velocity
WZE	The derivative of the z-component of the external velocity with respect to z, $\partial w_e/\partial z$, along the line of symmetry
DX	Dimensionless product of velocity and displacement thickness along x direction
DZ	Dimensionless product of velocity and displacement thickness along z direction
NPST	Number of points across the boundary layer
ITER	Number of iterations necessary to obtain converged boundary-layer solutions

5.0 SAMPLE CALCULATIONS

To illustrate the use of the computer program described in the previous section, we consider two sample calculations. The first one corresponds to flow over a submarine hull only and the second one corresponds to flow over a submarine hull/sail combination.

5.1 Submarine Hull

The calculations for this case are performed for an angle of attack of 10°. The input data of unit 5 are given below.

```
    2  1.000000
 10.000000
ETAE        VGP        DTETA(1)   RL
12.0        1.10       0.02         1400000.
   21    21    21    21    21    21    21    21    21    21    21    21    21    21    21
   21    21    21    21    21    21    21    21    21    21    21    21    21    21    21
   21    21    21    21    21    21    21    21    21    21    21    21    21    21    21
   21    21    21    21    21    21    21    21    21    21    21    21    21    21    21
   21
```

The input data of unit 11 which contain the grid points used in both inviscid and viscous calculations are given below.

```
      0
    74    23
 0.          3.          9.          18.         27.         36.         45.
 54.         63.         72.         81.         90.         99.         108.
 117.        126.        135.        144.        153.        162.        171.
 177.        180.
 0.          .005        .01         .025        .05         .075        .1
 .15         .2          .25         .3          .4          .5          .6
 .7          .8          .9          1.0         1.2         1.4         1.6
 1.8         2.0         2.2         2.4         2.6         2.8         3.0
 3.2         3.4         3.6         3.8         4.0         4.2         4.4
 4.6         4.8         5.0         5.25        5.5         5.75        6.0
 6.25        6.5         6.75        7.0         7.25        7.5         7.75
 8.0         8.25        8.5         8.75        9.0         9.25        9.5
 9.75        10.0        10.25       10.5        10.75       11.0        11.25
 11.5        11.75       12.0        12.25       12.5        12.75       13.0
 13.25       13.5        13.75       14.0
   146    61
 .001        .0025       .005        .01         .025        .05         .075
 .1          .15         .2          .25         .3          .35         .4
 .45         .5          .6          .7          .8          .9          1.0
 1.1         1.2         1.3         1.4         1.5         1.6         1.7
 1.8         1.9         2.0         2.1         2.2         2.3         2.4
 2.5         2.6         2.7         2.8         2.9         3.0         3.1
 3.2         3.3         3.4         3.5         3.6         3.7         3.8
 3.9         4.0         4.1         4.2         4.3         4.4         4.5
 4.6         4.7         4.8         4.9         5.0         5.1         5.2
```

```
5.3      5.4      5.5      5.6      5.7      5.8      5.9
6.0      6.1      6.2      6.3      6.4      6.5      6.6
6.7      6.8      6.9      7.0      7.1      7.2      7.3
7.4      7.5      7.6      7.7      7.8      7.9      8.0
8.1      8.2      8.3      8.4      8.5      8.6      8.7
8.8      8.9      9.0      9.1      9.2      9.3      9.4
9.5      9.6      9.7      9.8      9.9      10.0     10.1
10.2     10.3     10.4     10.5     10.6     10.7     10.8
10.9     11.0     11.1     11.2     11.3     11.4     11.5
11.6     11.7     11.8     11.9     12.0     12.1     12.2
12.3     12.4     12.5     12.6     12.7     12.8     12.9
13.0     13.1     13.2     13.3     13.4     13.5
0.       3.       6.       9.       12.      15.      18.
21.      24.      27.      30.      33.      36.      39.
42.      45.      48.      51.      54.      57.      60.
63.      66.      69.      72.      75.      78.      81.
84.      87.      90.      93.      96.      99.      102.
105.     108.     111.     114.     117.     120.     123.
126.     129.     132.     135.     138.     141.     144.
147.     150.     153.     156.     159.     162.     165.
168.     171.     174.     177.     180.
```

The output contains both inviscid and boundary-layer parameters on the grid points and is very long. For simplicity we only show the results of inviscid flow calculations for the first two strips and the results of boundary-layer calculations for the line of symmetry and the first streamwise station.

```
SUMMARY OF READ

    1   SECTIONS HAVE READ SUCCESSFULLY
 1702   COORDS READ

SECTION :  1
     NON LIFTING SECTION


NUMBER OF ANGLES OF ATTACK      1
PRINT CONTROL FLAG  1
SYMMETRY CONTROL FLAG  2
POSITIVE SYMMETRY CONDITION ON Y

TOTAL NUMBER OF PANELS      1606.0
TOTAL NUMBER OF ON BODY PANELS1606
TOTAL NUMBER OF LIFTING STRIPS   0


      5158472  VELOCITY FIELD CALCULATIONS


 4913078  FAR  FIELD CALCULATIONS    95.2 % OF TOTAL
  245394  NEAR FIELD CALCULATIONS     4.8 % OF TOTAL


     SOLUTION FOR    10.00000 ANGLE OF ATTACK

1         SECTION : 1
```

IL	IC	X	Y	Z	SIGMA	VN	VX	VY	VZ	VT	CP
1	1	0.00333	0.00123	0.04704	0.10162	0.00000	0.02923	0.00266	0.41270	0.41374	0.82882
1	2	0.00333	0.00492	0.04675	0.10177	0.00000	0.02914	0.01183	0.41203	0.41323	0.82924
1	3	0.00333	0.01096	0.04563	0.10192	0.00000	0.02872	0.02743	0.40924	0.41117	0.83094
1	4	0.00333	0.01796	0.04336	0.10194	0.00000	0.02771	0.04557	0.40334	0.40685	0.83447
1	5	0.00333	0.02452	0.04002	0.10199	0.00000	0.02622	0.06236	0.39478	0.40053	0.83958
1	6	0.00333	0.03048	0.03569	0.10206	0.00000	0.02429	0.07759	0.38370	0.39222	0.84616

1	7	0.00333	0.03569	0.03048	0.10215	0.00000	0.02200	0.09085	0.37041	0.38202	0.85406
1	8	0.00333	0.04002	0.02452	0.10225	0.00000	0.01935	0.10193	0.35520	0.37005	0.86307
1	9	0.00333	0.04336	0.01796	0.10237	0.00000	0.01645	0.11051	0.33848	0.35644	0.87295
1	10	0.00333	0.04563	0.01096	0.10249	0.00000	0.01334	0.11634	0.32055	0.34127	0.88353
1	11	0.00333	0.04678	0.00363	0.10262	0.00000	0.01013	0.11930	0.30195	0.32482	0.89449
1	12	0.00333	0.04678	-0.00368	0.10275	0.00000	0.00687	0.11933	0.28306	0.30726	0.90559
1	13	0.00333	0.04563	-0.01096	0.10287	0.00000	0.00367	0.11642	0.26444	0.28895	0.91651
1	14	0.00333	0.04336	-0.01796	0.10299	0.00000	0.00056	0.11063	0.24649	0.27018	0.92700
1	15	0.00333	0.04002	-0.02452	0.10311	0.00000	-0.00234	0.10209	0.22972	0.25140	0.93680
1	16	0.00333	0.03569	-0.03048	0.10322	0.00000	-0.00499	0.09101	0.21444	0.23301	0.94571
1	17	0.00333	0.03048	-0.03569	0.10331	0.00000	-0.00727	0.07774	0.20106	0.21569	0.95348
1	18	0.00333	0.02452	-0.04002	0.10339	0.00000	-0.00918	0.06249	0.18994	0.20016	0.95993
1	19	0.00333	0.01796	-0.04336	0.10346	0.00000	-0.01066	0.04564	0.18130	0.18726	0.96493
1	20	0.00333	0.01096	-0.04563	0.10352	0.00000	-0.01166	0.02741	0.17532	0.17783	0.96838
1	21	0.00333	0.00492	-0.04675	0.10338	0.00000	-0.01208	0.01177	0.17253	0.17336	0.96995
1	22	0.00333	0.00123	-0.04704	0.10323	0.00000	-0.01217	0.00263	0.17187	0.17232	0.97031
2	1	0.00763	0.00223	0.08501	0.09222	0.00000	0.09742	0.00521	0.53425	0.54308	0.70506
2	2	0.00764	0.00888	0.08449	0.09255	0.00000	0.09722	0.02339	0.53305	0.54234	0.70586
2	3	0.00764	0.01980	0.08246	0.09291	0.00000	0.09616	0.05453	0.52766	0.53912	0.70935
2	4	0.00764	0.03246	0.07835	0.09304	0.00000	0.09354	0.09063	0.51606	0.53224	0.71672
2	5	0.00764	0.04431	0.07231	0.09329	0.00000	0.08971	0.12416	0.49927	0.52223	0.72727
2	6	0.00764	0.05508	0.06449	0.09363	0.00000	0.08475	0.15470	0.47750	0.50904	0.74088
2	7	0.00764	0.06449	0.05508	0.09404	0.00000	0.07883	0.18151	0.45130	0.49278	0.75717
2	8	0.00764	0.07231	0.04431	0.09451	0.00000	0.07205	0.20399	0.42121	0.47352	0.77578
2	9	0.00764	0.07835	0.03246	0.09503	0.00000	0.06457	0.22156	0.38791	0.45137	0.79627
2	10	0.00764	0.08246	0.01980	0.09559	0.00000	0.05659	0.23376	0.35221	0.42649	0.81810
2	11	0.00764	0.08454	0.00666	0.09616	0.00000	0.04831	0.24021	0.31494	0.39902	0.84078
2	12	0.00764	0.08454	-0.00666	0.09675	0.00000	0.03992	0.24081	0.27692	0.36915	0.86373
2	13	0.00764	0.08246	-0.01980	0.09732	0.00000	0.03168	0.23551	0.23928	0.33723	0.88628
2	14	0.00764	0.07835	-0.03246	0.09787	0.00000	0.02371	0.22430	0.20288	0.30337	0.90797
2	15	0.00764	0.07231	-0.04431	0.09839	0.00000	0.01624	0.20744	0.16857	0.26779	0.92829
2	16	0.00764	0.06449	-0.05508	0.09887	0.00000	0.00946	0.18531	0.13728	0.23082	0.94672
2	17	0.00764	0.05508	-0.06449	0.09928	0.00000	0.00356	0.15848	0.10981	0.19284	0.96281
2	18	0.00764	0.04431	-0.07231	0.09963	0.00000	-0.00135	0.12753	0.08681	0.15428	0.97620
2	19	0.00764	0.03246	-0.07835	0.09991	0.00000	-0.00513	0.09323	0.06895	0.11607	0.98653
2	20	0.00764	0.01980	-0.08246	0.10015	0.00000	-0.00767	0.05596	0.05652	0.07991	0.99362

1 SECTION : 1

IL	IC	X	Y	Z	SIGMA	VN	VX	VY	VZ	VT	CP
2	21	0.00764	0.00888	-0.08449	0.09988	0.00000	-0.00875	0.02391	0.05072	0.05676	0.99678
2	22	0.00763	0.00223	-0.08501	0.09954	0.00000	-0.00899	0.00528	0.04942	0.05051	0.99745

SECTION : 1 TYPE = NO LIFT

BODY SUMMARY

FORCE 0.108860E+00 0.669197E+02 0.174114E+02
LIFT FORCE 0.154557E-02 LIFT COEFFICIENT 0.154557E-02
DRAG FORCE 0.463145E-03 DRAG COEFFICIENT 0.463145E-03
AREA 0.100000E+01
0 NXT = 146 NZT = 61 NPT = 99 LPRNT = 147
0 ETAE = 12.00000 VGP= 1.10000 DETA(1) = 0.02000 RL = 0.14000E+07
0*-
0NZ = 1

0 NX	X(NX)	Z(NZ)	V(WALL)	T(WALL)	UE	WZE	DX	NP	IT
1	0.00100	0.00000	0.00000	0.00000	-0.26366	0.28943	0.00000	0	0
2	0.00250	0.00000	0.00000	0.00000	-0.20244	0.28165	0.00000	0	0
3	0.00500	0.00000	0.00000	0.00000	-0.11798	0.27124	0.00000	0	0
4	0.01000	0.00000	0.00000	0.00000	-0.00487	0.25854	0.00000	0	0
5	0.02500	0.00000	0.04478	0.17539	0.13664	0.24783	0.08607	44	4
6	0.05000	0.00000	0.33825	0.21750	0.31834	0.23547	0.08981	44	5
7	0.07500	0.00000	0.42833	0.22868	0.44318	0.23177	0.15896	44	4
8	0.10000	0.00000	0.54590	0.23272	0.53129	0.22879	0.20292	44	3
9	0.15000	0.00000	0.67490	0.24518	0.66137	0.22509	0.27786	44	4
10	0.20000	0.00000	0.79991	0.27699	0.75788	0.22919	0.33843	44	3

11	0.25000	0.00000	0.78210	0.28059	0.82187	0.23389	0.40870	44	3
12	0.30000	0.00000	0.80338	0.29110	0.86471	0.23764	0.46933	44	3
13	0.35000	0.00000	0.73251	0.28718	0.89158	0.24072	0.53685	44	3
14	0.40000	0.00000	0.82698	0.31260	0.91800	0.24480	0.57091	44	3
15	0.45000	0.00000	0.76340	0.30871	0.93988	0.24899	0.62274	44	3
16	0.50000	0.00000	0.77236	0.31663	0.95423	0.25236	0.67222	44	3
17	0.60000	0.00000	0.68315	0.31979	0.97128	0.25881	0.77275	44	3
18	0.70000	0.00000	0.68251	0.32885	0.97974	0.26406	0.85481	44	3
19	0.80000	0.00000	0.61091	0.32478	0.98324	0.26792	0.93697	44	3
20	0.90000	0.00000	0.62525	0.34157	0.98410	0.27175	1.00005	44	3
21	1.00000	0.00000	0.85209	0.41456	0.98346	0.27454	0.96316	44	2
22	1.10000	0.00000	1.46447	0.57700	0.98218	0.27581	0.93325	44	3
23	1.20000	0.00000	2.01675	0.72759	0.98242	0.27745	1.01404	44	3
24	1.30000	0.00000	2.43208	0.83584	0.98343	0.27885	1.16551	44	3
25	1.40000	0.00000	2.64101	0.89544	0.98461	0.27941	1.34740	44	2
26	1.50000	0.00000	2.81636	0.94377	0.98633	0.27980	1.53253	44	2
27	1.60000	0.00000	2.90397	0.97904	0.98883	0.28066	1.71363	44	2
28	1.70000	0.00000	2.99166	1.00552	0.99192	0.28151	1.88407	44	2
29	1.80000	0.00000	3.04630	1.02564	0.99559	0.28196	2.04258	45	1
30	1.90000	0.00000	3.12455	1.04836	0.99966	0.28238	2.19132	45	2
31	2.00000	0.00000	3.16577	1.06805	1.00400	0.28306	2.33176	46	1
32	2.10000	0.00000	3.24782	1.09300	1.00843	0.28381	2.46265	46	2
33	2.20000	0.00000	3.29284	1.11094	1.01281	0.26445	2.58758	46	2
34	2.30000	0.00000	3.37128	1.13659	1.01693	0.28523	2.70936	47	1
35	2.40000	0.00000	3.41052	1.16017	1.02061	0.28649	2.83036	47	2
36	2.50000	0.00000	3.47296	1.18541	1.02367	0.28792	2.94939	47	2
37	2.60000	0.00000	3.50022	1.20466	1.02591	0.28924	3.07129	48	1
38	2.70000	0.00000	3.54234	1.22759	1.02723	0.29069	3.19542	48	2
39	2.80000	0.00000	3.54521	1.24894	1.02744	0.29254	3.32278	48	2
40	2.90000	0.00000	3.56544	1.27002	1.02658	0.29444	3.45202	48	2
41	3.00000	0.00000	3.54550	1.28423	1.02448	0.29616	3.58544	48	2
42	3.10000	0.00000	3.55275	1.30004	1.02152	0.29763	3.71942	49	1
43	3.20000	0.00000	3.52575	1.30761	1.01781	0.29868	3.85520	49	2
44	3.30000	0.00000	3.52287	1.31710	1.01392	0.29947	3.98327	49	2
45	3.40000	0.00000	3.51729	1.32824	1.01046	0.30010	4.09703	49	2
46	3.50000	0.00000	3.53811	1.34174	1.00750	0.30059	4.19764	49	2
47	3.60000	0.00000	3.55867	1.35561	1.00540	0.30094	4.28278	50	1
48	3.70000	0.00000	3.60017	1.37346	1.00381	0.30125	4.35979	50	2
49	3.80000	0.00000	3.61658	1.38784	1.00248	0.30163	4.43037	50	2
50	3.90000	0.00000	3.65972	1.40631	1.00140	0.30200	4.49367	50	2
51	4.00000	0.00000	3.68061	1.42029	1.00044	0.30229	4.55282	50	2
52	4.10000	0.00000	3.72309	1.43769	0.99963	0.30253	4.60689	50	2
53	4.20000	0.00000	3.74716	1.45209	0.99893	0.30274	4.65705	50	1
54	4.30000	0.00000	3.79151	1.47022	0.99832	0.30294	4.70402	50	2
55	4.40000	0.00000	3.81158	1.48407	0.99778	0.30319	4.74777	50	1
56	4.50000	0.00000	3.85686	1.50264	0.99731	0.30342	4.78811	50	2
57	4.60000	0.00000	3.87751	1.51587	0.99687	0.30363	4.82605	50	1
58	4.70000	0.00000	3.92343	1.53384	0.99648	0.30380	4.86123	50	2
59	4.80000	0.00000	3.94422	1.54511	0.99613	0.30387	4.89432	50	1
60	4.90000	0.00000	3.99028	1.56291	0.99583	0.30394	4.92498	50	2
61	5.00000	0.00000	4.01156	1.57638	0.99557	0.30410	4.95379	50	1
62	5.10000	0.00000	4.05763	1.59482	0.99534	0.30428	4.98046	50	2
63	5.20000	0.00000	4.07879	1.60716	0.99513	0.30443	5.00591	50	1
64	5.30000	0.00000	4.11908	1.62260	0.99493	0.30454	5.02906	50	1
65	5.40000	0.00000	4.14683	1.63656	0.99476	0.30462	5.05123	50	1
66	5.50000	0.00000	4.18590	1.65076	0.99462	0.30466	5.07179	50	1
67	5.60000	0.00000	4.21417	1.66460	0.99450	0.30469	5.09123	50	1
68	5.70000	0.00000	4.25282	1.67915	0.99439	0.30473	5.10953	50	1
69	5.80000	0.00000	4.28092	1.69323	0.99431	0.30479	5.12685	50	1
70	5.90000	0.00000	4.31912	1.70794	0.99425	0.30487	5.14296	50	1
71	6.00000	0.00000	4.34758	1.72245	0.99421	0.30497	5.15798	50	1
72	6.10000	0.00000	4.38578	1.73681	0.99419	0.30507	5.17207	50	1
73	6.20000	0.00000	4.41368	1.74962	0.99418	0.30510	5.18558	50	1
74	6.30000	0.00000	4.45157	1.76297	0.99417	0.30509	5.19839	50	1
75	6.40000	0.00000	4.47913	1.77557	0.99417	0.30508	5.21052	50	1
76	6.50000	0.00000	4.51710	1.78929	0.99420	0.30508	5.22181	50	1
77	6.60000	0.00000	4.54475	1.80189	0.99425	0.30508	5.23250	50	1
78	6.70000	0.00000	4.58278	1.81581	0.99431	0.30509	5.24250	50	1

79	6.80000	0.00000	4.61044	1.82816	0.99438	0.30510	5.25198	50	1
80	6.90000	0.00000	4.64850	1.84103	0.99447	0.30506	5.26084	50	1
81	7.00000	0.00000	4.67628	1.85178	0.99459	0.30496	5.26930	50	1
82	7.10000	0.00000	4.71432	1.86449	0.99471	0.30486	5.27726	50	1
83	7.20000	0.00000	4.74237	1.87704	0.99486	0.30482	5.28486	50	1
84	7.30000	0.00000	4.78041	1.89046	0.99503	0.30481	5.29191	50	1
85	7.40000	0.00000	4.80885	1.90199	0.99522	0.30477	5.29861	50	1
86	7.50000	0.00000	4.84689	1.91341	0.99543	0.30465	5.30489	50	1
87	7.60000	0.00000	4.87574	1.92463	0.99566	0.30453	5.31092	50	1
88	7.70000	0.00000	4.91399	1.93758	0.99591	0.30446	5.31653	50	1
89	7.80000	0.00000	4.94337	1.94946	0.99620	0.30440	5.32181	50	1
90	7.90000	0.00000	4.98198	1.96164	0.99651	0.30433	5.32666	50	1
91	8.00000	0.00000	5.01184	1.97206	0.99686	0.30421	5.33119	50	1
92	8.10000	0.00000	5.05094	1.98368	0.99724	0.30406	5.33538	50	1
93	8.20000	0.00000	5.08145	1.99418	0.99765	0.30391	5.33937	50	1
94	8.30000	0.00000	5.12124	2.00578	0.99810	0.30376	5.34304	50	1
95	8.40000	0.00000	5.15265	2.01625	0.99860	0.30360	5.34643	50	1
96	8.50000	0.00000	5.19359	2.02801	0.99914	0.30344	5.34944	50	1
97	8.60000	0.00000	5.22631	2.03801	0.99973	0.30326	5.35210	50	1
98	8.70000	0.00000	5.26889	2.04858	1.00039	0.30303	5.35431	50	1
99	8.80000	0.00000	5.30347	2.05777	1.00111	0.30276	5.35620	50	1
100	8.90000	0.00000	5.34798	2.06832	1.00190	0.30247	5.35769	50	1
101	9.00000	0.00000	5.38478	2.07791	1.00278	0.30218	5.35891	50	1
102	9.10000	0.00000	5.43187	2.08796	1.00374	0.30186	5.35951	50	1
103	9.20000	0.00000	5.47201	2.09590	1.00482	0.30146	5.35960	50	1
104	9.30000	0.00000	5.52284	2.10511	1.00602	0.30101	5.35897	50	1
105	9.40000	0.00000	5.56750	2.11376	1.00736	0.30056	5.35768	50	1
106	9.50000	0.00000	5.62315	2.12454	1.00885	0.30013	5.35558	50	1
107	9.60000	0.00000	5.67420	2.13266	1.01054	0.29965	5.35225	50	1
108	9.70000	0.00000	5.75239	2.14618	1.01245	0.29904	5.34958	50	2
109	9.80000	0.00000	5.79388	2.14606	1.01463	0.29832	5.34532	50	1
110	9.90000	0.00000	5.88089	2.15903	1.01714	0.29754	5.33847	50	2
111	10.00000	0.00000	5.93541	2.15968	1.02002	0.29671	5.32910	50	1
112	10.10000	0.00000	6.04746	2.17415	1.02346	0.29577	5.31555	50	2
113	10.20000	0.00000	6.14312	2.17907	1.02742	0.29462	5.30253	50	2
114	10.30000	0.00000	6.25828	2.18404	1.03230	0.29335	5.28180	50	2
115	10.40000	0.00000	6.40902	2.19511	1.03859	0.29203	5.24808	50	2
116	10.50000	0.00000	6.60427	2.21142	1.04668	0.29071	5.19997	50	2
117	10.60000	0.00000	6.82235	2.23549	1.05659	0.28961	5.14181	50	3
118	10.70000	0.00000	7.11591	2.27128	1.06930	0.28887	5.06347	50	3
119	10.80000	0.00000	7.39849	2.31297	1.08361	0.28866	4.98806	50	3
120	10.90000	0.00000	7.68713	2.36164	1.09824	0.28919	4.93438	50	3
121	11.00000	0.00000	7.91420	2.41273	1.11223	0.29067	4.91303	50	3
122	11.10000	0.00000	8.09960	2.45795	1.12447	0.29283	4.93100	50	2
123	11.20000	0.00000	8.15669	2.49572	1.13318	0.29562	5.00587	50	2
124	11.30000	0.00000	8.14832	2.51871	1.13855	0.29888	5.12768	50	1
125	11.40000	0.00000	8.03175	2.52901	1.14070	0.30250	5.29237	50	2
126	11.50000	0.00000	7.95475	2.55258	1.13954	0.30635	5.50345	50	1
127	11.60000	0.00000	7.66654	2.52307	1.13563	0.31033	5.75677	50	3
128	11.70000	0.00000	7.42464	2.50374	1.12925	0.31431	6.03890	50	3
129	11.80000	0.00000	7.16954	2.48372	1.12078	0.31822	6.35369	50	3
130	11.90000	0.00000	6.89603	2.44765	1.11064	0.32195	6.69989	50	3
131	12.00000	0.00000	6.61098	2.40723	1.09922	0.32540	7.07282	50	3
132	12.10000	0.00000	6.33040	2.36232	1.08679	0.32873	7.47026	50	3
133	12.20000	0.00000	6.05323	2.32217	1.07374	0.33207	7.88573	50	3
134	12.30000	0.00000	5.79104	2.27790	1.06028	0.33536	8.31474	50	3
135	12.40000	0.00000	5.53773	2.23617	1.04667	0.33849	8.74899	50	3
136	12.50000	0.00000	5.31258	2.19380	1.03315	0.34141	9.18449	51	1
137	12.60000	0.00000	5.08997	2.15782	1.01985	0.34421	9.60704	51	3
138	12.70000	0.00000	4.91348	2.13320	1.00696	0.34697	10.00477	52	1
139	12.80000	0.00000	4.73876	2.11735	0.99454	0.34969	10.36137	52	3
140	12.90000	0.00000	4.60668	2.11693	0.98267	0.35237	10.65567	52	3
141	13.00000	0.00000	4.48798	2.13526	0.97143	0.35503	10.86400	52	3
142	13.10000	0.00000	4.40581	2.17041	0.96075	0.35750	10.96447	53	1
143	13.20000	0.00000	4.34173	2.23561	0.95068	0.35982	10.91934	53	2
144	13.30000	0.00000	4.31136	2.32071	0.94108	0.36168	10.69097	53	2
145	13.40000	0.00000	4.29376	2.45387	0.93144	0.36318	10.25022	53	2
146	13.50000	0.00000	4.33099	2.62865	0.92165	0.36407	9.54873	53	2

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ONZ = 61

0 NX	X(NX)	Z(NZ)	V(WALL)	T(WALL)	UE	WZE	DX	NP	IT
1	0.00100	3.14159	0.05781	-0.05395	0.31146	-0.29062	0.00000	44	4
2	0.00250	3.14159	0.14392	-0.09497	0.37978	-0.30068	0.09831	44	4
3	0.00500	3.14159	0.26547	-0.14724	0.47198	-0.31396	0.12575	44	4
4	0.01000	3.14159	0.40029	-0.20363	0.58786	-0.32954	0.16776	44	4
5	0.02500	3.14159	0.44601	-0.23319	0.70134	-0.33836	0.26838	44	3
6	0.05000	3.14159	0.81816	-0.30778	0.85670	-0.34543	0.30460	44	4
7	0.07500	3.14159	0.83296	-0.29389	0.95757	-0.34487	0.37660	44	3
8	0.10000	3.14159	0.91285	-0.32085	1.01959	-0.34506	0.43409	44	3
9	0.15000	3.14159	0.89341	-0.29941	1.09662	-0.34448	0.54119	44	3
10	0.20000	3.14159	0.99553	-0.27462	1.15210	-0.33730	0.61434	44	3
11	0.25000	3.14159	0.83037	-0.24754	1.18093	-0.33120	0.72333	44	3
12	0.30000	3.14159	0.80474	-0.23285	1.19197	-0.32680	0.82286	44	3
13	0.35000	3.14159	0.56228	-0.20398	1.18760	-0.32379	0.97196	44	3
14	0.40000	3.14159	0.72538	-0.19471	1.18869	-0.32029	1.01651	44	3
15	0.45000	3.14159	0.54548	-0.16844	1.18915	-0.31696	1.12172	44	3
16	0.50000	3.14159	0.57759	-0.15829	1.18447	-0.31436	1.21739	44	3
17	0.60000	3.14159	0.35340	-0.11585	1.16998	-0.31008	1.46882	44	4
18	0.70000	3.14159	0.36972	-0.09807	1.15355	-0.30722	1.68712	44	4
19	0.80000	3.14159	0.19207	-0.06626	1.13739	-0.30570	1.97913	44	4
20	0.90000	3.14159	0.25349	-0.05203	1.12288	-0.30482	2.18693	44	4
21	1.00000	3.14159	0.42323	-0.11833	1.10958	-0.30465	1.95384	44	4
22	1.10000	3.14159	1.20924	-0.31633	1.09716	-0.30505	1.72369	44	5
23	1.20000	3.14159	1.86388	-0.50446	1.08867	-0.30517	1.77073	44	4
24	1.30000	3.14159	2.40824	-0.63569	1.08258	-0.30531	1.95995	44	4
25	1.40000	3.14159	2.66060	-0.71409	1.07763	-0.30577	2.22303	45	2
26	1.50000	3.14159	2.88821	-0.75599	1.07402	-0.30613	2.52096	47	1
27	1.60000	3.14159	2.93664	-0.76529	1.07164	-0.30595	2.83550	48	1
28	1.70000	3.14159	3.05186	-0.77107	1.07021	-0.30562	3.15817	49	1
29	1.80000	3.14159	3.02931	-0.76007	1.06951	-0.30554	3.48660	50	1
30	1.90000	3.14159	3.10584	-0.75213	1.06933	-0.30532	3.81124	50	2
31	2.00000	3.14159	3.08367	-0.73114	1.06941	-0.30460	4.13910	51	1
32	2.10000	3.14159	3.16324	-0.72027	1.06957	-0.30372	4.46762	52	1
33	2.20000	3.14159	3.13785	-0.69934	1.06956	-0.30296	4.80641	53	1
34	2.30000	3.14159	3.19228	-0.68031	1.06923	-0.30209	5.15079	53	2
35	2.40000	3.14159	3.15945	-0.65107	1.06835	-0.30088	5.50904	54	1
36	2.50000	3.14159	3.20110	-0.62850	1.06683	-0.29969	5.87963	54	2
37	2.60000	3.14159	3.14878	-0.60085	1.06448	-0.29890	6.27333	55	1
38	2.70000	3.14159	3.16970	-0.57468	1.06129	-0.29821	6.68661	55	2
39	2.80000	3.14159	3.09660	-0.53716	1.05714	-0.29734	7.13218	56	1
40	2.90000	3.14159	3.09556	-0.50566	1.05214	-0.29659	7.60081	56	2
41	3.00000	3.14159	3.00611	-0.46894	1.04624	-0.29616	8.10751	57	1
42	3.10000	3.14159	2.99627	-0.43714	1.03991	-0.29603	8.63691	58	1
43	3.20000	3.14159	2.91581	-0.40270	1.03348	-0.29626	9.18346	58	3
44	3.30000	3.14159	2.91506	-0.37062	1.02745	-0.29672	9.73571	59	1
45	3.40000	3.14159	2.86964	-0.33742	1.02252	-0.29736	10.26962	60	1
46	3.50000	3.14159	2.89212	-0.30436	1.01843	-0.29807	10.78214	60	2
47	3.60000	3.14159	2.86710	-0.26716	1.01524	-0.29868	11.27560	61	1
48	3.70000	3.14159	2.90815	-0.23201	1.01268	-0.29927	11.75100	62	1
49	3.80000	3.14159	2.89288	-0.19343	1.01049	-0.29983	12.21353	62	2
50	3.90000	3.14159	2.93464	-0.15502	1.00864	-0.30037	12.66608	63	1
51	4.00000	3.14159	2.92614	-0.11444	1.00705	-0.30090	13.10798	64	1
52	4.10000	3.14159	2.97135	-0.07303	1.00566	-0.30139	13.53334	64	2
53	4.20000	3.14159	2.96404	-0.02892	1.00442	-0.30178	13.95229	65	1
54	4.30000	3.14159	3.01098	0.01553	1.00331	-0.30210	14.35644	66	1
55	4.40000	3.14159	3.00890	0.06149	1.00233	-0.30238	14.74352	66	2
56	4.50000	3.14159	3.05546	0.10761	1.00145	-0.30263	15.11772	67	1
57	4.60000	3.14159	3.05718	0.15348	1.00067	-0.30293	15.47930	69	1
58	4.70000	3.14159	3.10453	0.20084	0.99996	-0.30321	15.81969	69	2
59	4.80000	3.14159	3.10825	0.24848	0.99932	-0.30344	16.14079	69	2
60	4.90000	3.14159	3.15732	0.29704	0.99875	-0.30364	16.44444	70	1
61	5.00000	3.14159	3.16445	0.34499	0.99823	-0.30382	16.72583	70	2
62	5.10000	3.14159	3.21390	0.39397	0.99776	-0.30399	16.99202	72	1
63	5.20000	3.14159	3.22293	0.44175	0.99733	-0.30414	17.23548	72	2
64	5.30000	3.14159	3.27270	0.49077	0.99693	-0.30428	17.45564	72	2
65	5.40000	3.14159	3.28461	0.53881	0.99657	-0.30437	17.65905	74	1
66	5.50000	3.14159	3.33576	0.58829	0.99625	-0.30440	17.83803	74	2
67	5.60000	3.14159	3.34887	0.63492	0.99595	-0.30444	17.99431	74	2
68	5.70000	3.14159	3.40199	0.68140	0.99568	-0.30455	18.13007	75	1
69	5.80000	3.14159	3.41723	0.72597	0.99545	-0.30470	18.24349	75	2
70	5.90000	3.14159	3.47045	0.77245	0.99522	-0.30480	18.33786	76	1

71	6.00000	3.14159	3.48718	0.81760	0.99501	-0.30482	18.41102	76	2
72	6.10000	3.14159	3.54122	0.86268	0.99482	-0.30483	18.46497	77	1
73	6.20000	3.14159	3.56023	0.90419	0.99467	-0.30491	18.49753	77	2
74	6.30000	3.14159	3.61536	0.94702	0.99454	-0.30501	18.51194	78	1
75	6.40000	3.14159	3.63585	0.98776	0.99443	-0.30509	18.50745	78	2
76	6.50000	3.14159	3.69149	1.03057	0.99434	-0.30510	18.48661	79	1
77	6.60000	3.14159	3.71330	1.06975	0.99426	-0.30508	18.44825	79	2
78	6.70000	3.14159	3.76978	1.11017	0.99420	-0.30508	18.39437	80	1
79	6.80000	3.14159	3.79294	1.14712	0.99415	-0.30508	18.32480	80	2
80	6.90000	3.14159	3.85003	1.18559	0.99412	-0.30508	18.24150	81	1
81	7.00000	3.14159	3.87425	1.22045	0.99411	-0.30510	18.14465	81	2
82	7.10000	3.14159	3.93184	1.25762	0.99411	-0.30509	18.03566	82	1
83	7.20000	3.14159	3.95709	1.29211	0.99412	-0.30502	17.91462	82	2
84	7.30000	3.14159	4.01513	1.32812	0.99416	-0.30492	17.78266	83	1
85	7.40000	3.14159	4.04138	1.35997	0.99420	-0.30483	17.64034	83	2
86	7.50000	3.14159	4.09984	1.39294	0.99427	-0.30479	17.48883	84	1
87	7.60000	3.14159	4.12705	1.42274	0.99435	-0.30476	17.32887	84	2
88	7.70000	3.14159	4.18594	1.45433	0.99445	-0.30473	17.16132	85	1
89	7.80000	3.14159	4.21399	1.48285	0.99456	-0.30470	16.98692	85	2
90	7.90000	3.14159	4.27252	1.51369	0.99470	-0.30463	16.80582	85	2
91	8.00000	3.14159	4.30203	1.54215	0.99485	-0.30450	16.61913	85	2
92	8.10000	3.14159	4.36163	1.57208	0.99502	-0.30436	16.42746	86	1
93	8.20000	3.14159	4.39144	1.59843	0.99522	-0.30421	16.23140	86	2
94	8.30000	3.14159	4.45123	1.62677	0.99544	-0.30405	16.03142	87	1
95	8.40000	3.14159	4.48193	1.65157	0.99568	-0.30390	15.82811	87	2
96	8.50000	3.14159	4.54150	1.67827	0.99596	-0.30375	15.62150	87	2
97	8.60000	3.14159	4.57397	1.70207	0.99627	-0.30360	15.41262	87	2
98	8.70000	3.14159	4.63491	1.72794	0.99661	-0.30344	15.20197	88	1
99	8.80000	3.14159	4.66786	1.75050	0.99699	-0.30327	14.98998	88	2
100	8.90000	3.14159	4.72934	1.77567	0.99741	-0.30309	14.77673	89	1
101	9.00000	3.14159	4.76354	1.79763	0.99788	-0.30288	14.56266	89	2
102	9.10000	3.14159	4.82559	1.82181	0.99840	-0.30267	14.34749	89	2
103	9.20000	3.14159	4.85295	1.83939	0.99898	-0.30246	14.13051	89	1
104	9.30000	3.14159	4.92709	1.86661	0.99963	-0.30224	13.91349	89	2
105	9.40000	3.14159	4.96808	1.88809	1.00037	-0.30197	13.69792	90	1
106	9.50000	3.14159	5.03430	1.91218	1.00120	-0.30165	13.48216	90	2
107	9.60000	3.14159	5.06601	1.92892	1.00214	-0.30129	13.26391	90	1
108	9.70000	3.14159	5.14705	1.95601	1.00321	-0.30093	13.04587	90	2
109	9.80000	3.14159	5.19933	1.97743	1.00444	-0.30056	12.82863	91	1
110	9.90000	3.14159	5.27472	2.00077	1.00588	-0.30014	12.61009	91	2
111	10.00000	3.14159	5.31625	2.01724	1.00755	-0.29964	12.38653	91	1
112	10.10000	3.14159	5.42096	2.04742	1.00960	-0.29912	12.15832	91	2
113	10.20000	3.14159	5.47392	2.06228	1.01194	-0.29862	11.92631	91	1
114	10.30000	3.14159	5.60952	2.09599	1.01499	-0.29811	11.68401	91	2
115	10.40000	3.14159	5.73974	2.12512	1.01928	-0.29757	11.41984	91	2
116	10.50000	3.14159	5.92072	2.15780	1.02530	-0.29701	11.12329	91	2
117	10.60000	3.14159	6.08620	2.19798	1.03235	-0.29614	10.81973	91	2
118	10.70000	3.14159	6.31290	2.25199	1.04085	-0.29466	10.50226	91	3
119	10.80000	3.14159	6.47366	2.31008	1.04945	-0.29255	10.21338	91	2
120	10.90000	3.14159	6.61790	2.38341	1.05665	-0.28967	9.99129	91	2
121	11.00000	3.14159	6.64724	2.46339	1.06121	-0.28589	9.86127	91	2
122	11.10000	3.14159	6.63972	2.54137	1.06285	-0.28169	9.81922	91	2
123	11.20000	3.14159	6.47660	2.61094	1.06036	-0.27730	9.88866	93	1
124	11.30000	3.14159	6.29615	2.67484	1.05413	-0.27299	10.05222	94	1
125	11.40000	3.14159	6.00462	2.72251	1.04455	-0.26914	10.30063	96	1
126	11.50000	3.14159	5.71423	2.75915	1.03180	-0.26608	10.63086	98	1
127	11.60000	3.14159	5.35671	2.79364	1.01653	-0.26360	11.03051	99	1
128	11.70000	3.14159	5.00609	2.81473	0.99925	-0.26170	11.48588	99	4
129	11.80000	3.14159	4.63429	2.83944	0.98039	-0.26037	11.98235	99	4
130	11.90000	3.14159	4.31179	2.86236	0.96046	-0.25958	12.50391	99	4
131	12.00000	3.14159	3.96334	2.88213	0.93993	-0.25933	13.02510	99	4
132	12.10000	3.14159	3.68725	2.90574	0.91909	-0.25969	13.52058	99	4
133	12.20000	3.14159	3.39449	2.92195	0.89838	-0.26069	13.95298	99	4
134	12.30000	3.14159	3.18051	2.94035	0.87805	-0.26238	14.28312	99	3
135	12.40000	3.14159	2.98375	2.97254	0.85836	-0.26488	14.47790	99	3
136	12.50000	3.14159	2.83427	2.99994	0.83959	-0.26827	14.49467	99	3
137	12.60000	3.14159	2.69229	3.04400	0.82190	-0.27219	14.28995	99	3
138	12.70000	3.14159	2.65731	3.12807	0.80550	-0.27631	13.83601	99	3
139	12.80000	3.14159	2.61173	3.21172	0.79058	-0.28072	13.12165	99	3
140	12.90000	3.14159	2.66348	3.33223	0.77731	-0.28554	12.15359	99	2
141	13.00000	3.14159	2.71055	3.45449	0.76586	-0.29081	10.96233	99	2
142	13.10000	3.14159	2.89408	3.64438	0.75653	-0.29635	9.59132	99	3
143	13.20000	3.14159	3.09571	3.84966	0.74935	-0.30214	8.13361	99	3
144	13.30000	3.14159	3.40354	4.09868	0.74498	-0.30798	6.65595	99	3
145	13.40000	3.14159	3.74751	4.36625	0.74383	-0.31387	5.24160	99	3
146	13.50000	3.14159	4.23170	4.67404	0.74645	-0.31965	3.96553	99	3

)NX = 5 NZSTP1 = 61

0 NZ	X(NX)	Z(NZ)	V(WALL)	T(WALL)	UE	WE	DX	DZ	NP	IT
2	0.02500	0.05236	0.04480	0.00919	0.13690	0.01298	0.08624	0.00504	44	5
3	0.02500	0.10472	0.04756	0.02114	0.13777	0.02799	0.08233	0.01027	44	4
4	0.02500	0.15708	0.04845	0.03260	0.13943	0.04349	0.08281	0.01598	44	4
5	0.02500	0.20944	0.05004	0.04536	0.14187	0.05935	0.08321	0.02153	44	3
6	0.02500	0.26180	0.05144	0.05691	0.14514	0.07512	0.08476	0.02731	44	3
7	0.02500	0.31416	0.05334	0.06881	0.14924	0.09058	0.08674	0.03294	44	3
8	0.02500	0.36652	0.05537	0.07999	0.15412	0.10574	0.08920	0.03849	44	3
9	0.02500	0.41888	0.05771	0.09092	0.15974	0.12045	0.09214	0.04395	44	3
10	0.02500	0.47124	0.06023	0.10112	0.16607	0.13465	0.09553	0.04927	44	3
11	0.02500	0.52360	0.06318	0.11152	0.17309	0.14842	0.09916	0.05433	44	3
12	0.02500	0.57596	0.06635	0.12134	0.18079	0.16177	0.10311	0.05921	44	3
13	0.02500	0.62832	0.06988	0.13120	0.18914	0.17470	0.10734	0.06387	44	3
14	0.02500	0.68068	0.07358	0.14031	0.19812	0.18713	0.11192	0.06838	44	3
15	0.02500	0.73304	0.07761	0.14935	0.20771	0.19904	0.11678	0.07265	44	3
16	0.02500	0.78540	0.08180	0.15765	0.21787	0.21040	0.12195	0.07673	44	3
17	0.02500	0.83776	0.08626	0.16586	0.22858	0.22118	0.12739	0.08056	44	3
18	0.02500	0.89012	0.09087	0.17334	0.23980	0.23136	0.13310	0.08415	44	3
19	0.02500	0.94248	0.09571	0.18063	0.25151	0.24092	0.13904	0.08749	44	3
20	0.02500	0.99484	0.10068	0.18712	0.26367	0.24981	0.14525	0.09059	44	3
21	0.02500	1.04720	0.10587	0.19329	0.27627	0.25801	0.15168	0.09342	44	3
22	0.02500	1.09956	0.11115	0.19869	0.28926	0.26548	0.15834	0.09599	44	3
23	0.02500	1.15192	0.11660	0.20384	0.30261	0.27223	0.16518	0.09825	44	2
24	0.02500	1.20428	0.12213	0.20821	0.31628	0.27823	0.17220	0.10023	44	2
25	0.02500	1.25664	0.12778	0.21225	0.33024	0.28348	0.17937	0.10190	44	2
26	0.02500	1.30900	0.13342	0.21546	0.34444	0.28795	0.18670	0.10330	44	2
27	0.02500	1.36136	0.1[illegible]912	0.21820	0.35883	0.29161	0.19418	0.10440	44	2
28	0.02500	1.41372	0.14481	0.22016	0.37339	0.29445	0.20179	0.10520	44	2
29	0.02500	1.46603	0.15056	0.22183	0.38806	0.29649	0.20946	0.10567	44	2
30	0.02500	1.51844	0.15628	0.22276	0.40282	0.29774	0.21720	0.10583	44	2
31	0.02500	1.57080	0.16201	0.22330	0.41762	0.29820	0.22497	0.10568	44	2
32	0.02500	1.62316	0.16763	0.22297	0.43242	0.29784	0.23281	0.10525	44	2
33	0.02500	1.67552	0.17317	0.22209	0.44718	0.29664	0.24072	0.10454	44	2
34	0.02500	1.72788	0.17857	0.22044	0.46185	0.29460	0.24866	0.10354	44	2
35	0.02500	1.78024	0.18395	0.21849	0.47641	0.29175	0.25656	0.10221	44	2
36	0.02500	1.83260	0.18914	0.21581	0.49080	0.28812	0.26442	0.10060	44	2
37	0.02500	1.88496	0.19425	0.21275	0.50499	0.28372	0.27223	0.09869	44	2
38	0.02500	1.93732	0.19914	0.20889	0.51894	0.27854	0.28000	0.09653	44	2
39	0.02500	1.98968	0.20385	0.20455	0.53262	0.27259	0.28774	0.09412	44	2
40	0.02500	2.04204	0.20832	0.19950	0.54598	0.26587	0.29542	0.09146	44	2
41	0.02500	2.09440	0.21266	0.19416	0.55900	0.25842	0.30297	0.08852	44	2
42	0.02500	2.14675	0.21674	0.18813	0.57164	0.25028	0.31041	0.08535	44	2
43	0.02500	2.19911	0.22063	0.18179	0.58386	0.24146	0.31771	0.08195	44	3
44	0.02500	2.25147	0.22416	0.17476	0.59563	0.23198	0.32490	0.07834	44	3
45	0.02500	2.30383	0.22741	0.16737	0.60691	0.22186	0.33198	0.07454	44	3
46	0.02500	2.35619	0.23030	0.15936	0.61766	0.21112	0.33893	0.07056	44	3
47	0.02500	2.40855	0.23299	0.15112	0.62786	0.19981	0.34569	0.06639	44	3
48	0.02500	2.46091	0.23526	0.14228	0.63748	0.18796	0.35230	0.06207	44	3
49	0.02500	2.51327	0.23730	0.13323	0.64650	0.17559	0.35871	0.05760	44	3
50	0.02500	2.56563	0.23892	0.12364	0.65490	0.16276	0.36496	0.05302	44	3
51	0.02500	2.61799	0.24019	0.11378	0.66264	0.14947	0.37109	0.04834	44	3
52	0.02500	2.67035	0.24109	0.10351	0.66971	0.13576	0.37701	0.04356	44	3
53	0.02500	2.72271	0.24183	0.09322	0.67610	0.12174	0.38254	0.03868	44	3
54	0.02500	2.77507	0.24230	0.08270	0.68178	0.10751	0.38757	0.03377	44	3
55	0.02500	2.82743	0.24251	0.07203	0.68673	0.09310	0.39229	0.02889	44	3
56	0.02500	2.87979	0.24218	0.06088	0.69098	0.07850	0.39702	0.02407	44	3
57	0.02500	2.93215	0.24210	0.04998	0.69454	0.06384	0.40087	0.01928	44	3
58	0.02500	2.98451	0.24063	0.03823	0.69739	0.04900	0.40567	0.01465	44	3
59	0.02500	3.03687	0.23761	0.02613	0.69949	0.03365	0.41271	0.01000	44	4
60	0.02500	3.08923	0.23275	0.01359	0.70086	0.01772	0.42192	0.00520	44	4

0

5.2 Submarine Hull/Sail Configuration

The input data of unit 5 for this case are the same as those for submarine hull only and are given below:

```
    2  1.000000
 10.000000
ETAE       VGP        DTETA(1)  RL
12.0       1.10       0.02        1400000.
   21   21   21   21   21   21   21   21   21   21   21   21   21   21   21
   21   21   21   21   21   21   21   21   21   21   21   21   21   21   21
   21   21   21   21   21   21   21   21   21   21   21   21   21   21   21
   21   21   21   21   21   21   21   21   21   21   21   21   21   21   21
   21   21   21   21
```

The input data of unit 11 now also contain grid points on sail and sail cap and are given below:

```
    1
   74   23
0.         3.         9.         18.        27.        36.        45.
54.        63.        72.        81.        90.        99.        108.
117.       126.       135.       144.       153.       162.       171.
177.       180.
0.         .005       .01        .025       .05        .075       .1
.15        .2         .25        .3         .4         .5         .6
.7         .8         .9         1.0        1.2        1.4        1.6
1.8        2.0        2.2        2.4        2.6        2.8        2.9
2.95       3.0        3.032986   3.05       3.075      3.1        3.15
3.2        3.25       3.3        3.35       3.4        3.45       3.5
3.55       3.6        3.65       3.7        3.75       3.8        3.85
3.9        3.95       4.0        4.05       4.1        4.15       4.2
4.241319   4.3        4.4        4.5        4.75       5.0        5.5
6.5        7.5        8.5        9.5        10.5       11.5       12.0
12.5       13.0       13.5       14.0
   27
4.241319   4.2        4.15       4.1        4.05       4.0        3.95
3.9        3.85       3.8        3.75       3.7        3.65       3.6
3.55       3.5        3.45       3.4        3.35       3.3        3.25
3.2        3.15       3.1        3.075      3.05       3.032986
   27
3.032986   3.05       3.075      3.1        3.15       3.2        3.25
3.3        3.35       3.4        3.45       3.5        3.55       3.6
3.65       3.7        3.75       3.8        3.85       3.9        3.95
4.0        4.05       4.1        4.15       4.2        4.241319
  162   64
.001       .0025      .005       .01        .025       .05        .075
.1         .15        .2         .25        .3         .35        .4
.45        .5         .6         .7         .8         .9         1.0
1.1        1.2        1.3        1.4        1.5        1.6        1.7
1.8        1.9        2.0        2.1        2.2        2.3        2.4
2.5        2.6        2.7        2.8        2.9        2.95       3.0
3.032986   3.05       3.075      3.1        3.15       3.2        3.25
3.3        3.35       3.4        3.45       3.5        3.55       3.6
3.65       3.7        3.75       3.8        3.85       3.9        3.95
4.0        4.05       4.1        4.15       4.2        4.241319   4.3
```

4.4	4.5	4.6	4.7	4.8	4.9	5.0
5.1	5.2	5.3	5.4	5.5	5.6	5.7
5.8	5.9	6.0	6.1	6.2	6.3	6.4
6.5	6.6	6.7	6.8	6.9	7.0	7.1
7.2	7.3	7.4	7.5	7.6	7.7	7.8
7.9	8.0	8.1	8.2	8.3	8.4	8.5
8.6	8.7	8.8	8.9	9.0	9.1	9.2
9.3	9.4	9.5	9.6	9.7	9.8	9.9
10.0	10.1	10.2	10.3	10.4	10.5	10.6
10.7	10.8	10.9	11.0	11.1	11.2	11.3
11.4	11.5	11.6	11.7	11.8	11.9	12.0
12.1	12.2	12.3	12.4	12.5	12.6	12.7
12.8	12.9	13.0	13.1	13.2	13.3	13.4
13.5						
0.	3.	6.	9.	12.	15.	18.
21.	24.	27.	30.	33.	36.	39.
42.	45.	48.	51.	54.	57.	60.
63.	66.	69.	72.	75.	78.	81.
84.	87.	90.	93.	96.	99.	102.
105.	108.	111.	114.	117.	120.	123.
126.	129.	132.	135.	138.	141.	144.
147.	150.	153.	156.	159.	162.	165.
168.	171.	172.5	174.	175.5	177.	178.5
180.						

Only parts of the output for either inviscid and boundary-layer calculations are shown below:

```
SUMMARY OF READ

    3   SECTIONS HAVE READ SUCCESSFULLY
 1999   COORDS READ

SECTION :  1
     NON LIFTING SECTION

SECTION :  2
     NON LIFTING SECTION

SECTION :  3
     NON LIFTING SECTION


NUMBER OF ANGLES OF ATTACK       1
PRINT CONTROL FLAG  1
SYMMETRY CONTROL FLAG  2
POSITIVE SYMMETRY CONDITION ON Y

TOTAL NUMBER OF PANELS      1840.0
TOTAL NUMBER OF ON BODY PANELS1840
TOTAL NUMBER OF LIFTING STRIPS    0

      6771200  VELOCITY FIELD CALCULATIONS


 6321128  FAR  FIELD CALCULATIONS    93.4 % OF TOTAL
  450072  NEAR FIELD CALCULATIONS     6.6 % OF TOTAL
```

SOLUTION FOR 10.00000 ANGLE OF ATTACK

1 SECTION : 1

IL	IC	X	Y	Z	SIGMA	VN	VX	VY	VZ	VT	CP
1	1	0.00333	0.00123	0.04704	0.10157	0.00000	0.02918	0.00266	0.41202	0.41306	0.82938
1	2	0.00333	0.00492	0.04675	0.10172	0.00000	0.02909	0.01183	0.41134	0.41254	0.82981
1	3	0.00333	0.01096	0.04563	0.10187	0.00000	0.02867	0.02742	0.40856	0.41048	0.83150
1	4	0.00333	0.01796	0.04336	0.10189	0.00000	0.02766	0.04555	0.40266	0.40617	0.83502
1	5	0.00333	0.02452	0.04002	0.10194	0.00000	0.02618	0.06234	0.39410	0.39986	0.84011
1	6	0.00333	0.03048	0.03569	0.10201	0.00000	0.02426	0.07756	0.38304	0.39156	0.84668
1	7	0.00333	0.03569	0.03048	0.10210	0.00000	0.02197	0.09082	0.36975	0.38137	0.85456
1	8	0.00333	0.04002	0.02452	0.10220	0.00000	0.01933	0.10190	0.35455	0.36941	0.86354
1	9	0.00333	0.04336	0.01796	0.10232	0.00000	0.01643	0.11047	0.33783	0.35581	0.87340
1	10	0.00333	0.04563	0.01096	0.10244	0.00000	0.01333	0.11630	0.31991	0.34066	0.88395
1	11	0.00333	0.04678	0.00368	0.10257	0.00000	0.01012	0.11926	0.30132	0.32422	0.89488
1	12	0.00333	0.04678	-0.00368	0.10270	0.00000	0.00687	0.11929	0.28244	0.30667	0.90595
1	13	0.00333	0.04563	-0.01096	0.10282	0.00000	0.00367	0.11638	0.26383	0.28838	0.91684
1	14	0.00333	0.04336	-0.01796	0.10295	0.00000	0.00058	0.11059	0.24589	0.26961	0.92731
1	15	0.00333	0.04002	-0.02452	0.10306	0.00000	-0.00232	0.10205	0.22913	0.25084	0.93708
1	16	0.00333	0.03569	-0.03048	0.10317	0.00000	-0.00496	0.09098	0.21385	0.23245	0.94597
1	17	0.00333	0.03048	-0.03569	0.10326	0.00000	-0.00723	0.07772	0.20048	0.21514	0.95372
1	18	0.00333	0.02452	-0.04002	0.10334	0.00000	-0.00915	0.06247	0.18936	0.19961	0.96016
1	19	0.00333	0.01796	-0.04336	0.10341	0.00000	-0.01062	0.04563	0.18072	0.18669	0.96515
1	20	0.00333	0.01096	-0.04563	0.10347	0.00000	-0.01162	0.02741	0.17474	0.17726	0.96858
1	21	0.00333	0.00492	-0.04675	0.10333	0.00000	-0.01204	0.01177	0.17196	0.17278	0.97015
1	22	0.00333	0.00123	-0.04704	0.10318	0.00000	-0.01213	0.00263	0.17130	0.17175	0.97050
2	1	0.00763	0.00223	0.08501	0.09218	0.00000	0.09728	0.00521	0.53350	0.54233	0.70588
2	2	0.00764	0.00888	0.08449	0.09251	0.00000	0.09708	0.02338	0.53231	0.54159	0.70668
2	3	0.00764	0.01980	0.08246	0.09287	0.00000	0.09603	0.05451	0.52692	0.53837	0.71016
2	4	0.00764	0.03246	0.07835	0.09299	0.00000	0.09341	0.09060	0.51533	0.53150	0.71751
2	5	0.00764	0.04431	0.07231	0.09325	0.00000	0.08959	0.12411	0.49854	0.52151	0.72803
2	6	0.00764	0.05508	0.06449	0.09359	0.00000	0.08464	0.15464	0.47678	0.50833	0.74160
2	7	0.00764	0.06449	0.05508	0.09400	0.00000	0.07874	0.18144	0.45060	0.49210	0.75784
2	8	0.00764	0.07231	0.04431	0.09446	0.00000	0.07197	0.20392	0.42052	0.47286	0.77640
2	9	0.00764	0.07835	0.03246	0.09498	0.00000	0.06451	0.22149	0.38723	0.45074	0.79684
2	10	0.00764	0.08246	0.01980	0.09554	0.00000	0.05655	0.23368	0.35155	0.42590	0.81861
2	11	0.00764	0.08454	0.00666	0.09611	0.00000	0.04829	0.24013	0.31430	0.39846	0.84123
2	12	0.00764	0.08454	-0.00666	0.09670	0.00000	0.03991	0.24073	0.27630	0.36862	0.86412
2	13	0.00764	0.08246	-0.01980	0.09727	0.00000	0.03169	0.23543	0.23867	0.33674	0.88661
2	14	0.00764	0.07835	-0.03246	0.09782	0.00000	0.02374	0.22422	0.20228	0.30291	0.90824
2	15	0.00764	0.07231	-0.04431	0.09835	0.00000	0.01628	0.20736	0.16799	0.26737	0.92851
2	16	0.00764	0.06449	-0.05508	0.09882	0.00000	0.00951	0.18525	0.13672	0.23043	0.94690
2	17	0.00764	0.05508	-0.06449	0.09924	0.00000	0.00363	0.15842	0.10926	0.19248	0.96295
2	18	0.00764	0.04431	-0.07231	0.09958	0.00000	-0.00127	0.12749	0.08627	0.15394	0.97630
2	19	0.00764	0.03246	-0.07835	0.09986	0.00000	-0.00504	0.09319	0.06842	0.11572	0.98661
2	20	0.00764	0.01980	-0.08246	0.10010	0.00000	-0.00757	0.05594	0.05600	0.07951	0.99368

1 SECTION : 1

IL	IC	X	Y	Z	SIGMA	VN	VX	VY	VZ	VT	CP
2	21	0.00764	0.00888	-0.08449	0.09983	0.00000	-0.00865	0.02391	0.05020	0.05627	0.99683
2	22	0.00763	0.00223	-0.08501	0.09949	0.00000	-0.00889	0.00528	0.04890	0.04998	0.99750

SECTION : 1 TYPE = NO LIFT

SECTION : 2 TYPE = NO LIFT

SECTION : 3 TYPE = NO LIFT

BODY SUMMARY

FORCE -0.120509E+00 0.484947E+02 0.179167E+02
LIFT FORCE 0.141084E-01 LIFT COEFFICIENT 0.141084E-01
DRAG FORCE -0.287276E-02 DRAG COEFFICIENT -0.287276E-02
AREA 0.100000E+01
0 NXT = 162 NZT = 64 NPT = 99 LPRNT = 163
0 ETAE = 12.00000 VGP= 1.10000 DETA(1) = 0.02000 RL = 0.14000E+07
0*-*

0NZ = 1

0 NX	X(NX)	Z(NZ)	V(WALL)	T(WALL)	UE	WZE	DX	NP	IT
1	0.00100	0.00000	0.00000	0.00000	-0.26306	0.28878	0.00000	0	0
2	0.00250	0.00000	0.00000	0.00000	-0.20185	0.28105	0.00000	0	0
3	0.00500	0.00000	0.00000	0.00000	-0.11742	0.27071	0.00000	0	0
4	0.01000	0.00000	0.00000	0.00000	-0.00436	0.25801	0.00000	0	0
5	0.02500	0.00000	0.04491	0.17487	0.13709	0.24715	0.08637	44	4
6	0.05000	0.00000	0.33866	0.21725	0.31872	0.23505	0.08991	44	5
7	0.07500	0.00000	0.42854	0.22782	0.44351	0.23124	0.15909	44	4
8	0.10000	0.00000	0.54614	0.23209	0.53158	0.22820	0.20306	44	3
9	0.15000	0.00000	0.67492	0.24490	0.66160	0.22465	0.27801	44	4
10	0.20000	0.00000	0.79998	0.27587	0.75806	0.22865	0.33857	44	3
11	0.25000	0.00000	0.78199	0.27967	0.82202	0.23326	0.40888	44	3
12	0.30000	0.00000	0.80337	0.28969	0.86484	0.23693	0.46950	44	3
13	0.35000	0.00000	0.73228	0.28779	0.89169	0.24019	0.53707	44	3
14	0.40000	0.00000	0.82688	0.31075	0.91808	0.24423	0.57111	44	3
15	0.45000	0.00000	0.76311	0.30787	0.93995	0.24831	0.62299	44	3
16	0.50000	0.00000	0.77218	0.31500	0.95428	0.25164	0.67249	44	3
17	0.60000	0.00000	0.68282	0.31899	0.97132	0.25805	0.77309	44	3
18	0.70000	0.00000	0.68233	0.32728	0.97977	0.26329	0.85518	44	3
19	0.80000	0.00000	0.61058	0.32390	0.98327	0.26712	0.93743	44	3
20	0.90000	0.00000	0.62510	0.34010	0.98414	0.27096	1.00053	44	3
21	1.00000	0.00000	0.85169	0.41364	0.98350	0.27377	0.96365	44	2
22	1.10000	0.00000	1.46404	0.57451	0.98220	0.27500	0.93372	44	3
23	1.20000	0.00000	2.01651	0.72542	0.98245	0.27661	1.01447	44	3
24	1.30000	0.00000	2.43204	0.83257	0.98347	0.27799	1.16596	44	3
25	1.40000	0.00000	2.64113	0.89276	0.98467	0.27854	1.34791	44	2
26	1.50000	0.00000	2.81659	0.94036	0.98640	0.27894	1.53314	44	2
27	1.60000	0.00000	2.90419	0.97610	0.98891	0.27980	1.71436	44	2
28	1.70000	0.00000	2.99194	1.00195	0.99201	0.28065	1.88493	44	2
29	1.80000	0.00000	3.04664	1.02255	0.99570	0.28111	2.04356	45	1
30	1.90000	0.00000	3.12495	1.04463	0.99977	0.28152	2.19243	45	2
31	2.00000	0.00000	3.16604	1.06444	1.00411	0.28217	2.33309	46	1
32	2.10000	0.00000	3.24823	1.08885	1.00855	0.28290	2.46413	46	2
33	2.20000	0.00000	3.29408	1.10766	1.01297	0.28356	2.59081	47	1
34	2.30000	0.00000	3.37259	1.13303	1.01714	0.28438	2.71291	47	2
35	2.40000	0.00000	3.41116	1.15672	1.02084	0.28566	2.83349	47	2
36	2.50000	0.00000	3.47539	1.18231	1.02392	0.28711	2.95243	47	2
37	2.60000	0.00000	3.49621	1.20174	1.02593	0.28851	3.07665	48	1
38	2.70000	0.00000	3.54890	1.22586	1.02750	0.29003	3.19821	48	2
39	2.80000	0.00000	3.58258	1.25176	1.02942	0.29195	3.31150	48	2
40	2.90000	0.00000	3.60779	1.26424	1.02955	0.29318	3.43709	48	1
41	2.95000	0.00000	3.58531	1.26582	1.02831	0.29339	3.51142	48	1
42	3.00000	0.00000	3.56811	1.23381	1.02672	0.29218	3.58566	48	2
43	3.03299	0.00000	3.56454	1.18224	1.02599	0.28916	3.62896	48	2
44	3.05000	0.00000	3.56626	1.22060	1.02550	0.28861	3.65298	49	1
45	3.07500	0.00000	3.55221	1.27539	1.02453	0.29065	3.69082	49	2
46	3.10000	0.00000	3.54980	1.30349	1.02342	0.29319	3.72875	49	2
47	3.15000	0.00000	3.54190	1.30204	1.02110	0.29562	3.80335	49	1
48	3.20000	0.00000	3.53626	1.31485	1.01881	0.29677	3.87610	49	1
49	3.25000	0.00000	3.50905	1.31639	1.01629	0.29796	3.94915	49	1
50	3.30000	0.00000	3.49212	1.32797	1.01380	0.29913	4.01717	49	2
51	3.35000	0.00000	3.48900	1.32364	1.01163	0.29978	4.07683	49	1
52	3.40000	0.00000	3.50603	1.33855	1.00992	0.30022	4.12970	49	2
53	3.45000	0.00000	3.50628	1.33456	1.00857	0.30055	4.17664	49	1
54	3.50000	0.00000	3.53057	1.34860	1.00742	0.30071	4.21991	49	2
55	3.55000	0.00000	3.53201	1.34767	1.00639	0.30092	4.26192	50	1
56	3.60000	0.00000	3.55918	1.36426	1.00548	0.30116	4.30117	50	2
57	3.65000	0.00000	3.56764	1.36859	1.00470	0.30154	4.33859	50	1
58	3.70000	0.00000	3.59322	1.39285	1.00399	0.30227	4.37418	50	2
59	3.75000	0.00000	3.60017	1.38483	1.00335	0.30252	4.40822	50	1
60	3.80000	0.00000	3.62417	1.40587	1.00273	0.30275	4.44095	50	2
61	3.85000	0.00000	3.63122	1.40399	1.00213	0.30308	4.47291	50	1
62	3.90000	0.00000	3.65597	1.42021	1.00160	0.30324	4.50302	50	2
63	3.95000	0.00000	3.66335	1.42927	1.00110	0.30384	4.53218	50	1
64	4.00000	0.00000	3.68606	1.44503	1.00057	0.30439	4.56061	50	2
65	4.05000	0.00000	3.69465	1.44246	1.00008	0.30457	4.58772	50	1
66	4.10000	0.00000	3.71940	1.46032	0.99968	0.30481	4.61302	50	2
67	4.15000	0.00000	3.72754	1.46331	0.99927	0.30519	4.63781	50	1

68	4.20000	0.00000	3.74731	1.46880	0.99881	0.30512	4.66258	50	1
69	4.24132	0.00000	3.75737	1.45573	0.99849	0.30447	4.68206	50	1
70	4.30000	0.00000	3.78283	1.46239	0.99823	0.30352	4.70675	50	1
71	4.40000	0.00000	3.81433	1.48330	0.99779	0.30347	4.74831	50	2
72	4.50000	0.00000	3.85360	1.50150	0.99735	0.30366	4.78800	50	2
73	4.60000	0.00000	3.88516	1.51794	0.99707	0.30392	4.82357	50	2
74	4.70000	0.00000	3.92298	1.53537	0.99674	0.30412	4.85823	50	2
75	4.80000	0.00000	3.94972	1.54802	0.99638	0.30426	4.89137	50	1
76	4.90000	0.00000	3.99063	1.56687	0.99604	0.30439	4.92289	50	2
77	5.00000	0.00000	4.01508	1.57833	0.99576	0.30454	4.95182	50	1
78	5.10000	0.00000	4.05747	1.59786	0.99552	0.30469	4.97866	50	2
79	5.20000	0.00000	4.08203	1.60870	0.99531	0.30482	5.00382	50	1
80	5.30000	0.00000	4.12448	1.62806	0.99512	0.30494	5.02737	50	2
81	5.40000	0.00000	4.14862	1.63804	0.99494	0.30503	5.04979	50	1
82	5.50000	0.00000	4.19063	1.65706	0.99478	0.30511	5.07067	50	2
83	5.60000	0.00000	4.21481	1.66660	0.99465	0.30517	5.09045	50	1
84	5.70000	0.00000	4.25654	1.68536	0.99453	0.30522	5.10887	50	2
85	5.80000	0.00000	4.28062	1.69447	0.99443	0.30526	5.12632	50	1
86	5.90000	0.00000	4.31744	1.71111	0.99435	0.30529	5.14198	50	1
87	6.00000	0.00000	4.34792	1.72226	0.99429	0.30531	5.15703	50	1
88	6.10000	0.00000	4.38369	1.73859	0.99425	0.30534	5.17113	50	1
89	6.20000	0.00000	4.41471	1.74969	0.99422	0.30536	5.18448	50	1
90	6.30000	0.00000	4.44982	1.76552	0.99422	0.30536	5.19702	50	1
91	6.40000	0.00000	4.48095	1.77638	0.99423	0.30537	5.20879	50	1
92	6.50000	0.00000	4.51617	1.79200	0.99426	0.30536	5.21989	50	1
93	6.60000	0.00000	4.54703	1.80248	0.99432	0.30535	5.23028	50	1
94	6.70000	0.00000	4.58267	1.81801	0.99439	0.30532	5.24008	50	1
95	6.80000	0.00000	4.61335	1.82815	0.99448	0.30530	5.24929	50	1
96	6.90000	0.00000	4.64917	1.84348	0.99460	0.30526	5.25795	50	1
97	7.00000	0.00000	4.68002	1.85341	0.99473	0.30522	5.26613	50	1
98	7.10000	0.00000	4.71499	1.86875	0.99485	0.30518	5.27436	50	1
99	7.20000	0.00000	4.74568	1.87839	0.99499	0.30514	5.28204	50	1
100	7.30000	0.00000	4.78093	1.89333	0.99516	0.30508	5.28919	50	1
101	7.40000	0.00000	4.81198	1.90273	0.99535	0.30502	5.29580	50	1
102	7.50000	0.00000	4.84795	1.91747	0.99557	0.30495	5.30191	50	1
103	7.60000	0.00000	4.87959	1.92665	0.99583	0.30486	5.30756	50	1
104	7.70000	0.00000	4.91627	1.94116	0.99611	0.30477	5.31276	50	1
105	7.80000	0.00000	4.94859	1.95009	0.99644	0.30466	5.31756	50	1
106	7.90000	0.00000	4.98592	1.96429	0.99680	0.30454	5.32199	50	1
107	8.00000	0.00000	5.01879	1.97288	0.99720	0.30440	5.32606	50	1
108	8.10000	0.00000	5.05244	1.98717	0.99748	0.30428	5.33245	50	1
109	8.20000	0.00000	5.08426	1.99495	0.99781	0.30414	5.33791	50	1
110	8.30000	0.00000	5.11953	2.00837	0.99820	0.30398	5.34241	50	1
111	8.40000	0.00000	5.15379	2.01605	0.99868	0.30380	5.34579	50	1
112	8.50000	0.00000	5.19280	2.02940	0.99925	0.30359	5.34814	50	1
113	8.60000	0.00000	5.23071	2.03707	0.99992	0.30336	5.34946	50	1
114	8.70000	0.00000	5.27354	2.05020	1.00071	0.30311	5.34976	50	1
115	8.80000	0.00000	5.31561	2.05778	1.00163	0.30282	5.34904	50	1
116	8.90000	0.00000	5.36296	2.07072	1.00270	0.30250	5.34733	50	1
117	9.00000	0.00000	5.40980	2.07814	1.00391	0.30215	5.34466	50	1
118	9.10000	0.00000	5.46240	2.08590	1.00530	0.30157	5.34115	50	1
119	9.20000	0.00000	5.51464	2.09275	1.00686	0.30096	5.33694	50	1
120	9.30000	0.00000	5.58746	2.10765	1.00861	0.30034	5.33373	50	2
121	9.40000	0.00000	5.62860	2.10915	1.01057	0.29970	5.33003	50	1
122	9.50000	0.00000	5.70421	2.12441	1.01274	0.29908	5.32505	50	2
123	9.60000	0.00000	5.75367	2.12750	1.01514	0.29846	5.31908	50	1
124	9.70000	0.00000	5.83960	2.14530	1.01778	0.29787	5.31246	50	2
125	9.80000	0.00000	5.89571	2.14964	1.02068	0.29731	5.30501	50	1
126	9.90000	0.00000	5.99149	2.16999	1.02384	0.29679	5.29704	50	2
127	10.00000	0.00000	6.07609	2.18348	1.02727	0.29633	5.29126	50	2
128	10.10000	0.00000	6.17441	2.19104	1.03155	0.29562	5.27704	50	2
129	10.20000	0.00000	6.26957	2.20684	1.03610	0.29500	5.26373	50	2
130	10.30000	0.00000	6.37491	2.22182	1.04089	0.29450	5.25188	50	2
131	10.40000	0.00000	6.47316	2.24048	1.04591	0.29415	5.24139	50	2
132	10.50000	0.00000	6.58433	2.26146	1.05113	0.29398	5.23235	50	2
133	10.60000	0.00000	6.68696	2.28515	1.05653	0.29401	5.22496	50	2
134	10.70000	0.00000	6.80175	2.31204	1.06209	0.29427	5.21950	50	2
135	10.80000	0.00000	6.90675	2.33829	1.06778	0.29479	5.21881	50	2
136	10.90000	0.00000	7.02028	2.36396	1.07359	0.29561	5.22662	50	2
137	11.00000	0.00000	7.13441	2.39003	1.07978	0.29678	5.24208	50	2
138	11.10000	0.00000	7.41617	2.45172	1.09001	0.29896	5.21998	50	3
139	11.20000	0.00000	7.47278	2.46027	1.09961	0.30141	5.22347	50	1
140	11.30000	0.00000	7.72615	2.52435	1.10819	0.30408	5.25835	50	2

141	11.40000	0.00000	7.77165	2.53710	1.11538	0.30696	5.33333	50	1
142	11.50000	0.00000	7.83414	2.55705	1.12079	0.31000	5.44366	50	1
143	11.60000	0.00000	7.81143	2.56566	1.12404	0.31319	5.59427	50	1
144	11.70000	0.00000	7.77758	2.57457	1.12474	0.31648	5.79182	50	1
145	11.80000	0.00000	7.39730	2.51898	1.11976	0.31989	6.07975	50	3
146	11.90000	0.00000	7.10539	2.48488	1.11038	0.32336	6.42828	50	3
147	12.00000	0.00000	6.76557	2.43839	1.09929	0.32682	6.80536	50	3
148	12.10000	0.00000	6.48083	2.39808	1.08693	0.33022	7.20800	50	3
149	12.20000	0.00000	6.15035	2.34558	1.07374	0.33352	7.63004	50	3
150	12.30000	0.00000	5.93604	2.30582	1.06097	0.33656	8.04489	50	3
151	12.40000	0.00000	5.66989	2.25533	1.04855	0.33937	8.45406	50	3
152	12.50000	0.00000	5.48379	2.22121	1.03608	0.34203	8.86738	51	1
153	12.60000	0.00000	5.23770	2.17528	1.02368	0.34457	9.27274	51	3
154	12.70000	0.00000	5.08622	2.15344	1.01147	0.34699	9.65728	51	3
155	12.80000	0.00000	4.88724	2.13874	0.99960	0.34969	10.01222	52	1
156	12.90000	0.00000	4.77061	2.14078	0.98814	0.35238	10.31274	52	3
157	13.00000	0.00000	4.61931	2.14472	0.97718	0.35472	10.53578	52	3
158	13.10000	0.00000	4.56226	2.17499	0.96680	0.35658	10.65588	52	2
159	13.20000	0.00000	4.46132	2.20779	0.95712	0.35782	10.64044	52	2
160	13.30000	0.00000	4.47135	2.28110	0.94823	0.35831	10.44893	52	2
161	13.40000	0.00000	4.46713	2.37602	0.94021	0.35789	10.04481	52	2
162	13.50000	0.00000	4.58170	2.52615	0.93318	0.35644	9.38801	52	2

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0 VW BECAME NEGATIVE IT= 2

0**** NX = 40 NZ = 64 X = 0.29000E+01 Z = 0.31416E+01 UE=, 0.82869E+00 WE = 0.00000E+00 SWP=

UE = 0.8287E+00 WE = 0.0000E+00

0 J	ETA	F	U	V	G	W	T	B
1	0.000000	0.000000E+00	0.000000E+00	-0.346948E-01	0.000000E+00	0.000000E+00	0.122916E+02	0.100000E+01
6	0.122102	0.105210E-02	0.265771E-01	0.435064E+00	-0.210276E+00	0.101757E+01	0.635665E+01	0.108554E+01
11	0.318748	0.159084E-01	0.124422E+00	0.455563E+00	-0.920328E+00	0.121967E+01	0.623174E+01	0.225531E+01
16	0.635450	0.737278E-01	0.229839E+00	0.240797E+00	-0.188249E+01	0.121843E+01	-0.623954E+01	0.671411E+01
21	1.145500	0.215398E+00	0.313808E+00	0.996036E-01	-0.298175E+01	0.121645E+01	0.623174E+01	0.235595E+02
26	1.966941	0.497730E+00	0.366877E+00	0.451103E-01	-0.452473E+01	0.121324E+01	-0.623954E+01	0.713071E+02
31	3.289880	0.101603E+01	0.413326E+00	0.284760E-01	-0.718584E+01	0.120808E+01	0.623174E+01	0.142491E+03
36	5.420487	0.195305E+01	0.464593E+00	0.230073E-01	-0.118172E+02	0.119978E+01	-0.623954E+01	0.192234E+03
41	8.851851	0.368291E+01	0.543529E+00	0.227332E-01	-0.192666E+02	0.118640E+01	0.623174E+01	0.192234E+03
46	14.378097	0.701703E+01	0.659375E+00	0.185603E-01	-0.303886E+02	0.116485E+01	-0.623954E+01	0.192234E+03
51	23.278171	0.134793E+02	0.777972E+00	0.819200E-02	-0.434136E+02	0.113014E+01	0.623174E+01	0.192234E+03
56	35.956383	0.237367E+02	0.825366E+00	0.968499E-03	-0.527968E+02	0.108071E+01	-0.623954E+01	0.192234E+03
61	48.869377	0.344276E+02	0.828686E+00	-0.396830E-03	-0.589055E+02	0.103036E+01	0.623174E+01	0.192234E+03

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0NZ = 64

0 NX	X(NX)	Z(NZ)	V(WALL)	T(WALL)	UE	WZE	DX	NP	IT
1	0.00100	3.14159	0.05764	-0.05371	0.31085	-0.28962	0.00000	44	4
2	0.00250	3.14159	0.14351	-0.09782	0.37912	-0.30354	0.09830	44	4
3	0.00500	3.14159	0.26454	-0.15425	0.47127	-0.32173	0.12600	44	4
4	0.01000	3.14159	0.39875	-0.21382	0.58707	-0.34228	0.16829	44	4
5	0.02500	3.14159	0.44416	-0.23622	0.70050	-0.35150	0.26930	44	3
6	0.05000	3.14159	0.81560	-0.32465	0.85578	-0.36149	0.30550	44	4
7	0.07500	3.14159	0.83011	-0.29580	0.95656	-0.36007	0.37764	44	3
8	0.10000	3.14159	0.90989	-0.33431	1.01853	-0.36017	0.43519	44	3
9	0.15000	3.14159	0.89007	-0.30524	1.09548	-0.35990	0.54267	44	3
10	0.20000	3.14159	0.99228	-0.26723	1.15087	-0.34943	0.61577	44	3
11	0.25000	3.14159	0.82773	-0.23630	1.17963	-0.34030	0.72451	44	3
12	0.30000	3.14159	0.80256	-0.21995	1.19062	-0.33366	0.82365	44	3
13	0.35000	3.14159	0.56071	-0.18785	1.18618	-0.32869	0.97227	44	3
14	0.40000	3.14159	0.72417	-0.17494	1.18721	-0.32325	1.01592	44	3
15	0.45000	3.14159	0.54491	-0.14721	1.18760	-0.31808	1.12002	44	3
16	0.50000	3.14159	0.57753	-0.13564	1.18284	-0.31384	1.21420	44	3
17	0.60000	3.14159	0.35481	-0.09508	1.16818	-0.30703	1.46108	44	4
18	0.70000	3.14159	0.37211	-0.07862	1.15156	-0.30237	1.67314	44	4
19	0.80000	3.14159	0.19614	-0.04585	1.13518	-0.29908	1.95472	44	4
20	0.90000	3.14159	0.25828	-0.03491	1.12042	-0.29678	2.15102	44	4
21	1.00000	3.14159	0.42940	-0.09793	1.10680	-0.29564	1.92192	44	4
22	1.10000	3.14159	1.21428	-0.28383	1.09405	-0.29503	1.69859	44	4
23	1.20000	3.14159	1.85605	-0.46273	1.08513	-0.29424	1.74755	44	4

24	1.30000	3.14159	2.39335	-0.58933	1.07851	-0.29351	1.93535	44	4
25	1.40000	3.14159	2.63878	-0.66533	1.07294	-0.29323	2.19692	45	2
26	1.50000	3.14159	2.86000	-0.70284	1.06856	-0.29263	2.48945	46	1
27	1.60000	3.14159	2.91054	-0.70662	1.06524	-0.29094	2.80697	48	1
28	1.70000	3.14159	2.98593	-0.69370	1.06262	-0.28857	3.13089	49	1
29	1.80000	3.14159	2.97567	-0.67697	1.06046	-0.28597	3.45671	50	1
30	1.90000	3.14159	3.02186	-0.64351	1.05838	-0.28220	3.78625	50	2
31	2.00000	3.14159	2.98395	-0.59669	1.05609	-0.27675	4.11908	51	1
32	2.10000	3.14159	3.02705	-0.53508	1.05306	-0.26884	4.45937	52	1
33	2.20000	3.14159	2.95944	-0.45941	1.04895	-0.25887	4.81463	53	1
34	2.30000	3.14159	2.95440	-0.31998	1.04290	-0.24284	5.18684	53	3
35	2.40000	3.14159	2.84785	-0.17548	1.03461	-0.22169	5.58482	54	1
36	2.50000	3.14159	2.75538	0.21051	1.02207	-0.18102	6.02637	54	3
37	2.60000	3.14159	2.59562	0.35537	1.00678	-0.13970	6.48505	55	1
38	2.70000	3.14159	2.23679	2.04167	0.97786	0.00116	7.13179	58	1
39	2.80000	3.14159	1.73470	0.93149	0.93498	0.20790	8.11733	61	1

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0NX = 5 NZSTP1 = 64

0 NZ	X(NX)	Z(NZ)	V(WALL)	T(WALL)	UE	WE	DX	DZ	NP	IT
2	0.02500	0.05236	0.04494	0.00916	0.13735	0.01294	0.08654	0.00503	44	5
3	0.02500	0.10472	0.04772	0.02109	0.13823	0.02793	0.08259	0.01025	44	4
4	0.02500	0.15708	0.04860	0.03253	0.13988	0.04340	0.08309	0.01595	44	4
5	0.02500	0.20944	0.05019	0.04526	0.14231	0.05923	0.08348	0.02149	44	3
6	0.02500	0.26180	0.05158	0.05678	0.14557	0.07497	0.08503	0.02725	44	3
7	0.02500	0.31416	0.05348	0.06867	0.14967	0.09040	0.08700	0.03287	44	3
8	0.02500	0.36652	0.05550	0.07982	0.15453	0.10553	0.08946	0.03842	44	3
9	0.02500	0.41888	0.05783	0.09073	0.16014	0.12021	0.09240	0.04386	44	3
10	0.02500	0.47124	0.06034	0.10089	0.16646	0.13438	0.09578	0.04917	44	3
11	0.02500	0.52360	0.06329	0.11127	0.17347	0.14812	0.09941	0.05423	44	3
12	0.02500	0.57596	0.06646	0.12107	0.18115	0.16144	0.10335	0.05910	44	3
13	0.02500	0.62832	0.06998	0.13091	0.18949	0.17434	0.10757	0.06375	44	3
14	0.02500	0.68068	0.07367	0.13999	0.19845	0.18675	0.11214	0.06824	44	3
15	0.02500	0.73304	0.07769	0.14901	0.20801	0.19863	0.11700	0.07251	44	3
16	0.02500	0.78540	0.08187	0.15730	0.21816	0.20996	0.12216	0.07658	44	3
17	0.02500	0.83776	0.08632	0.16549	0.22884	0.22072	0.12758	0.08039	44	3
18	0.02500	0.89012	0.09091	0.17295	0.24004	0.23088	0.13328	0.08398	44	3
19	0.02500	0.94248	0.09575	0.18023	0.25173	0.24042	0.13922	0.08731	44	3
20	0.02500	0.99484	0.10070	0.18671	0.26386	0.24930	0.14541	0.09040	44	3
21	0.02500	1.04720	0.10587	0.19285	0.27643	0.25747	0.15184	0.09323	44	3
22	0.02500	1.09956	0.11114	0.19823	0.28940	0.26493	0.15849	0.09580	44	3
23	0.02500	1.15192	0.11657	0.20337	0.30272	0.27165	0.16531	0.09805	44	2
24	0.02500	1.20428	0.12208	0.20773	0.31636	0.27764	0.17232	0.10003	44	2
25	0.02500	1.25664	0.12771	0.21177	0.33028	0.28288	0.17947	0.10170	44	2
26	0.02500	1.30900	0.13334	0.21497	0.34445	0.28734	0.18679	0.10309	44	2
27	0.02500	1.36136	0.13903	0.21769	0.35881	0.29099	0.19426	0.10419	44	2
28	0.02500	1.41372	0.14471	0.21964	0.37334	0.29382	0.20186	0.10499	44	2
29	0.02500	1.46608	0.15045	0.22130	0.38798	0.29585	0.20952	0.10546	44	2
30	0.02500	1.51844	0.15616	0.22224	0.40271	0.29710	0.21724	0.10561	44	2
31	0.02500	1.57080	0.16187	0.22278	0.41747	0.29755	0.22499	0.10546	44	2
32	0.02500	1.62316	0.16747	0.22245	0.43224	0.29719	0.23282	0.10503	44	2
33	0.02500	1.67552	0.17298	0.22156	0.44696	0.29599	0.24072	0.10432	44	2
34	0.02500	1.72788	0.17837	0.21990	0.46160	0.29395	0.24865	0.10333	44	2
35	0.02500	1.78024	0.18373	0.21796	0.47613	0.29111	0.25653	0.10201	44	2
36	0.02500	1.83260	0.18892	0.21529	0.49048	0.28748	0.26438	0.10039	44	2
37	0.02500	1.88496	0.19402	0.21224	0.50464	0.28309	0.27217	0.09849	44	2
38	0.02500	1.93732	0.19889	0.20839	0.51856	0.27792	0.27993	0.09633	44	2
39	0.02500	1.98968	0.20358	0.20405	0.53220	0.27198	0.28765	0.09392	44	2
40	0.02500	2.04204	0.20803	0.19900	0.54553	0.26527	0.29532	0.09127	44	2
41	0.02500	2.09440	0.21236	0.19367	0.55852	0.25784	0.30286	0.08834	44	2
42	0.02500	2.14675	0.21643	0.18766	0.57112	0.24971	0.31028	0.08517	44	2
43	0.02500	2.19911	0.22030	0.18134	0.58332	0.24091	0.31757	0.08177	44	3
44	0.02500	2.25147	0.22383	0.17432	0.59506	0.23145	0.32474	0.07817	44	3
45	0.02500	2.30383	0.22706	0.16695	0.60631	0.22135	0.33181	0.07438	44	3
46	0.02500	2.35619	0.22995	0.15896	0.61703	0.21064	0.33874	0.07041	44	3
47	0.02500	2.40855	0.23263	0.15075	0.62721	0.19935	0.34549	0.06625	44	3
48	0.02500	2.46091	0.23490	0.14193	0.63681	0.18753	0.35208	0.06194	44	3
49	0.02500	2.51327	0.23693	0.13290	0.64580	0.17519	0.35848	0.05748	44	3
50	0.02500	2.56563	0.23855	0.12333	0.65418	0.16238	0.36472	0.05291	44	3

51	0.02500	2.61799	0.23982	0.11350	0.66190	0.14912	0.37083	0.04824	44	3
52	0.02500	2.67035	0.24072	0.10325	0.66895	0.13545	0.37673	0.04346	44	3
53	0.02500	2.72271	0.24146	0.09299	0.67533	0.12146	0.38225	0.03860	44	3
54	0.02500	2.77507	0.24192	0.08249	0.68099	0.10726	0.38727	0.03370	44	3
55	0.02500	2.82743	0.24213	0.07184	0.68593	0.09289	0.39198	0.02883	44	3
56	0.02500	2.87979	0.24180	0.06072	0.69017	0.07832	0.39670	0.02402	44	3
57	0.02500	2.93215	0.24173	0.04985	0.69371	0.06369	0.40053	0.01924	44	3
58	0.02500	2.98451	0.24028	0.03814	0.69655	0.04889	0.40530	0.01462	44	3
59	0.02500	3.01069	0.23914	0.03223	0.69770	0.04131	0.40848	0.01231	44	3
60	0.02500	3.03687	0.23714	0.02598	0.69865	0.03358	0.41241	0.00998	44	3
61	0.02500	3.06305	0.23600	0.02012	0.69944	0.02577	0.41547	0.00758	44	3
62	0.02500	3.08923	0.23109	0.01338	0.70002	0.01768	0.42334	0.00523	44	4
63	0.02500	3.11541	0.22632	0.00707	0.70038	0.00920	0.43308	0.00267	44	4

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